PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited.

41 PARK ROW (TIMES BUILDING), NEW YORK.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)

In requesting your address changed, give **old** *as well as new address.*

ESTABLISHED 19 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

In the growth of THE ELECTRICAL WORLD, in circulation, size and general improvement, the **value of its columns for reaching those engaged in electrical pursuits** has not failed to be **appreciated by advertisers.**

The following table shows **the steady onward march** of the paper in this department of its business, notwithstanding the numerous recent consolidations among electrical companies:

The first issue of					1888 cont'ined		175	different	adv'ts.
1881 contained		28	different	adv'ts.	1889	"	234	"	"
1882	"	45	"	"	1890	"	289	"	"
1883	"	63	"	"	1891	"	325	"	"
1884	"	82	"	"	1892	"	316	"	"
1885	"	100	"	"	1893	"	317	"	"
1886	"	138	"	"					
1887	"	154	"	"					

No announcements of the Publisher are included in this list.

"WANT" AND "FOR SALE" ADVERTISEMENTS

are a special feature of **THE ELECTRICAL WORLD.** Position Wanted small advertisements cost but $1 an insertion; Help Wanted and For Sale small advertisements cost but $1.50 an insertion. Remit in advance for the number of insertions desired.

THE ELECTRICAL WORLD'S Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.

Address and make drafts, orders, etc., payable to

THE ELECTRICAL WORLD,

41 Park Row, New York,

OR ANY OF THE BRANCH OFFICES.

VOL. XXII. NEW YORK, SEPT. 9, 1893. NO. 11.

CONTENTS.

EDITORIAL: PAGE
Paragraphs ... 189

ILLUSTRATED ARTICLES:
Practical Aspects of Low Frequency Electrical Resonance—V., by M. I. Pupin ... 190
The Members of the International Electrical Congress ... 191
Judging the Electrical Exhibits at the World's Fair, by H. S. Hering ... 192
Electricity at the World's Fair ... 194
Multiphase Motors and the Transmission of Power ... 196
Iron for Transformers, by Prof. J. A. Ewing ... 198
A New Incandescent Arc, by L. B. Marks ... 199
On the Carrying Capacity of Electric Cables Submerged, Buried, or Suspended in Air—II., by A. E. Kennelly ... 201
A Bicycle Dynamo ... 202
A Constant Speed, Direct-Connected Electric Elevator ... 203
The Intramural Railway at the World's Fair ... 203
A Snap Switch ... 203

MISCELLANEOUS:
The General Electric Sued by the Western Electric ... 190
The American Electro-Therapeutic Association ... 190
Electric Traction in Germany ... 192
The Tariff War Between Germany and Russia ... 192
Some Measurements of the Temperature Variation in the Electrical Resistance of Copper Wire, by A. E. Kennelly and R. A. Fessenden ... 198
Electrical Engineering Symbols, by Prof. A. Jamieson ... 198
Underground Wires for Electric Lighting and Power Distribution, by Prof. D. C. Jackson ... 199
On Direct Current Dynamos of Very High Potential, by Prof. F. B. Crocker ... 201
A Novelty in Electric Lighting ... 203

FINANCIAL ... 204
AFFAIRS OF THE COMPANIES ... 204
SPECIAL CORRESPONDENCE: New York Notes, 204; New England Notes, 204; Western Notes, 204.
NEWS OF THE WEEK: Electric Light and Power, 204; The Electric Railway, 205.
TRADE AND INDUSTRIAL NOTES ... 205
BUSINESS NOTICES ... 205
OUR ILLUSTRATED PATENT RECORD ... 205

An Early Issue. OWING to the fact that Monday, Sept. 4, is a legal holiday, THE ELECTRICAL WORLD, according to its regular custom, goes to press on Friday, three days earlier than usual.

Electrical Symbols. THE action of the International Electrical Congress in giving unofficial countenance to Prof. Hospitalier's admirable system of nomenclature, notation and symbols, with a few changes, will, it is hoped, settle this matter for some years at least. As the system thus recognized is based upon rational principles, and was developed with every consideration for practical convenience, it will probably be received with general public approbation, without which even the most pronounced official action of the Congress would have sittle or no result. While there are several good points in the symbols of Prof. Jamieson, printed in another column, there are some to which decided objections can be made. The symbolical representations of electrical apparatus given may be of use in electrical manuals or in specification work, and perhaps in a few other special cases but scarcely elsewhere. The use of τ for small differences of temperature is objectionable, as it is almost universally used to denote an absolute temperature, and no valid objections can, it seems, be urged against the retention of dt. Similar or other objections apply to δ for dyne, ε for erg, and Ω for megohm. The system seems to be entirely arbitrary in its construction, and although it may be convenient, as remarked before, for special purposes, it does not appear to be adapted for general use. As remarked by a great authority, the multiplication of names and symbols tends toward a scientific volapük, intelligible only to the initiated, and thus defeats the end aimed at.

Borrowed Plumage. IF imitation is truly the sincerest flattery we acknowledge the compliment implied, perhaps unconsciously, by two of our electrical contemporaries in attempting to copy—in a feeble manner, it is true—one of the several features of THE ELECTRICAL WORLD'S International Electrical Congress issue. Knowing that our readers would appreciate portraits of the distinguished delegates to the Congress we went to considerable trouble to procure photographs of as many of these as possible from which to make engravings Of these photographs a number were taken especially for THE ELECTRICAL WORLD and others were supplied to it exclusively. Several copies of these particular ones, nevertheless, appeared in the aforesaid contemporaries the week after they were published by us; one frankly used direct reproductions—though forgetting to acknowledge the source—while the other characteristically thought to conceal the theft by a ruse that would not deceive the merest tyro. As the copied portraits in both cases were not at all flattering to the subjects, we will, in order to avoid this in the future, be willing to lend to our backward contemporaries electrotypes of portraits for publication in their issue following the one in which they appear in THE ELECTRICAL WORLD, upon condition that they make the usual acknowledgment in their columns. They will thus not only give an unusual treat to their readers, but also bear frank witness to the enterprise of a journal they have long since ceased to attempt to rival and now merely strive to imitate.

Electrical Resonance. DR. PUPIN'S paper on the practical aspects of low frequency resonance, the conclusion of which we print in this issue, is a notable one from several points of view. Leaving aside the theoretical points of importance developed, a practical one of consequence is the simple method outlined by means of which, by a proper proportioning of capacity and self-induction, electrical energy may be transformed from low to high potential; while at present the complication is undoubtedly much greater than in a transformer, yet this may be overcome in the future, and at any rate a valuable addition is made in this respect to the resources of the laboratory. The mechanical analogue by means of which, with the aid of a model, the effects of capacity, self-induction and resistance are compared to those of elasticity, inertia and friction respectively, is unusually interesting and suggestive, and enables a clearer conception of electrical resonance to be obtained than is perhaps otherwise possible to the student first entering a subject abounding, as this one does, in new conceptions. The method adopted throughout by Dr. Pupin of assisting to the grasp of ideas by showing their analogy to others already acquired is an admirable one and is always productive of good results, provided that the analogy does not become confounded in the mind of the student with an identity. The ingenious electrodynamic current interrupter devised by Dr. Pupin, combined with his telephonic method of detecting and "weeding out" harmonics, cannot fail to have a stimulating effect on researches in this field so recently opened up, which may have results of great practical importance, either directly, or indirectly are by exposing the mechanism of alternating current phenomena. With such able investigators as Pupin, Duncan and Tesla, all of whom have shown an exceptional fertility in devising tools with which to arrive at the secrets of nature, the electrical public may look forward to a great extension in electrical knowledge in this new and interesting field.

Carrying Capacity of Electric Cables. THE experimental researches of Kennelly into the carrying capacity of electric conductors under the conditions in which they are used in practical electrical lighting applications have become classical, and the results, adopted throughout the world, have apparently fixed for all time limiting dimensions of ordinary electric lighting and power conductors with reference to the heating effect due to the passage of a current. Very few, if any, investigations in the electrical field have had a more important practical bearing than these, and very few investigators have had their work honored by such quick and universal recognition and adoption. Scarcely less important are the extension and generalization of the same subject given in the recent paper of Mr. Kennelly read before the annual meeting at Chicago of the Association of Edson Illuminating Companies. While the results here given are perhaps not in as practical shape as the former ones, their application is far more general and the equations and curves given will enable tables to be computed to apply to the specific cases that may have to be considered in a certain line of work. By referring to the example worked out for the same cable when submerged, buried underground or suspended in air, it will be seen that the carrying capacity varies widely in the different cases. In round numbers, the carrying capacity of the cable referred to is 180, 145 and 100 respectively in the three cases named. It will be noted that the carrying capacity of a cable is least when suspended in the air, even considering the effect of convection. As a consequence, in most cases the calculation need only be made for that condition alone, even if the other two are also present, but in extensive installations a notable saving in copper may be made by proportioning the cable for each condition if the question of heating effect enters. Owing to differences in the character of soil and to the different conductive qualities of the same soil under different conditions, it would seem that there should be a considerable variation in the value of the ground resistance which would influence the carrying capacity, calculated from an average value. If this is true it would be interesting to know between what limits the value of G varies, and if in any practical case the carrying capacity would be less than that of an aerial conductor. In Europe the system of distribution by cables buried in a bed of sand is becoming widely adopted, and the excellent results obtained point to its general use in the future, so that it is a matter of importance to know the value of G for this case, particularly in dry weather. This, however, only involves the value of a constant and does not, of course, affect the formulæ otherwise nor the underlying principles.

Multiphase Motors and the Transmission of Power. ONE of the features of the recent International Electrical Congress at Chicago was the discussion which took place in Section C multiphase motors and the transmission of power. A glance at the official programme would at once have called attention to the fact that no paper was to be presented on this most important subject, a fact which would occasion some surprise in view of the great interest manifested and the important development made in this line during the past few years. The matter was not overlooked, however, and as it was known that many of the most eminent authorities on this question in the world were to be present, including not only those of our own countrymen who had taken a most active part in the development of the transmission of power, but especially those from abroad whose wide experience in alternating current work would prove particularly valuable to American engineers, it was arranged to have a discussion opened in the section of Pure Practice for the purpose of drawing out the visiting electricians as far as possible. To this end Dr. Louis Duncan, with whom the idea is said to have originated, opened the discussion during the session of Thursday, and so successful did it prove that this section, which at the beginning of the congress bid fair, in point of the number of papers at least, to be weakest of the three, attracted so many from the other two sections that they both adjourned for a short period. The discussion continued not only through that session but through the next as well, to the end of the congress, and was followed with the closest attention and greatest interest. Many points were brought out which were of real value and which showed along what lines progress in the future might be expected. Advocates of the three systems—continuous current, single phase and multiphase transmission—were present, and set forth the advantages of their respective systems, citing installations in operation to prove their practicability and efficiency. It was evident that the champions of the direct current were decidedly in the minority, although many instances were given in which such plants had proved an undoubted success. The real battle lay between the single, two and three phase alternating current systems. The general opinion of the foreign engineers seemed to be that the single phase system was the system of the future, and they were supported in this by several Americans whose opinions are well worthy of consideration. Those of our own engineers who had had extended experience in alternating current work were inclined to favor multiphase distribution. Opinion was pretty evenly divided between the two-phase and three-phase systems The announcement by Prof. Geo. Forbes that it had been decided to use a two-phase independent circuit system at Niagara Falls, and employ both synchronous single-phase and multiphase motors, was received with great interest. It was apparent from the discussion that both these types of motors were regarded as entirely practicable, with reasonable limitations. Another important question briefly considered was that of frequency, and it was stated that from 30 to 35 periods per second was probably the lower limit for the successful transmission of power. If arc and incandescent lighting was to be done this limit would have to be raised at least to 50 periods. Whether step-up transformers should be used or the generators should be built for very high potential was a point upon which there seemed to be quite a wide difference of opinion. The question of the line did not receive much consideration. Prof. Forbes stated that for the first contract at Niagara Falls, for a very short transmission, subways would be used, meaning by subways underground conduits sufficiently large for a man to pass through for inspection of the wires. The cost of such a line over any great distance would unquestionably be prohibitive.

The General Electric Sued by the Western Electric.

The Western Electric Company has entered suit in the Superior Court of Cook County, Illinois, against the General Electric Company and certain of its employees for damages to the extent of $10,000 for removing certain advertising signs from electric light poles in the Electricity Building of the World's Fair.

In the complaint it is stated that at the solicitation of Prof. Barrett the Western Electric Company erected 30 iron arc light poles in the Electricity Building, under an agreement, and as a consideration for furnishing the poles the Western Electric was to be allowed to place its name on a brass plate near the base of each pole and also on glass signs inserted in the hood or covering at the top, with the understanding that in the case of lamps furnished by other manufacturers than itself these should be marked with the names of such companies, thus giving to them due credit for their lamps and to the Western Electric Company credit for the poles.

Of these poles 27 were furnished with arc lamps by the General Electric Company, and the latter vainly endeavored to secure the removal of the glass signs bearing the name of the Western Electric from these poles, but were refused permission by Prof. Barrett. The complaint of the Western Electric states that on the night of July 17, between the hours of 11 p. m. and 2 a. m., five employees of the General Electric, under the direction of Lieut. E. J. Spencer, entered the Electricity Building and unlawfully removed the signs from the 27 posts on which were lamps of the General Electric Company. Since then, the complaint adds, attempts to gain possession of the glass signs have proved fruitless, and it is further charged that the five defendants who actually removed the signs have been induced by the General Electric Company and Lieutenant Spencer to abscond to avoid criminal prosecution.

American Electro-Therapeutic Association.

The following is the preliminary programme of the American Electro-Therapeutic Association, which will hold its third annual meeting in Chicago, Sept. 12, 13 and 14:

Discussions.—(1) "What Are the Possibilities of Electricity in the Treatment of Fibroid Growths?" Discussion will be opened by Dr. J. H. Kellogg, of Battle Creek, Mich. The following among others have been asked to take part:

M. le Docteur Georges Apostoli, of Paris. M. le Docteur Georges Gautier, of Paris. Dr. La Torre, of Rome. Dr. Augustin H. Goelet, of New York. Dr. A. Lapthorn Smith, of Montreal. Dr. Franklin H. Martin, of Chicago. Dr. Margaret A. Cleaves, of New York. Dr. G. Belton Massey, of Philadelphia. Dr. George F. Hulbert, of St. Louis. Dr. E. L. H. McGinnis, of New York.

(2) "The Influence of Frequency of Interruptions and Character of Induced Current Waves Upon Physiological Effect." Discussion will be opened by Prof. J. W. Morton, of New York. The following among others have been asked to take part:

M. le Prof. d'Arsonval, of Paris. Prof. Du Bois-Reymond, of Berlin. Mr. Newman Lawrence, of London. M. le Docteur Larat, of Paris. Prof. Edwin J. Houston, of Philadelphia. M. le Docteur Apostoli, of Paris. M. G. Weisse, of Paris. Dr. W. J. Herdman, of Ann Arbor, Mich. Mr. J. J. Carty, of New York. Dr. J. H. Kellogg, of Battle Creek, Mich. Dr. A. H. Goelet, of New York. Dr. Weir Mitchell, of Philadelphia. Dr. A. D. Rockwell, of New York. Dr. Frederick Peterson, of New York. Dr. W. F. Hutchinson, of Providence, R. I. Dr. Georges Gautier, of Paris. Dr. Franklin Martin, of Chicago.

The following papers will be read:

1. "The Nutritional Effects of Statical Electricity," by Prof. W. J. Morton, M.D., New York. 2. "Electro-Medical Eccentricities," by Newman Lawrence, M. I. E. E., London, England. 3. "The Graphic Study of Electrical Currents in Relation to Therapeutics," by J. H. Kellogg, M.D., Battle Creek, Mich. 4. "The Action of the Continuous Current Within the Living Tissues as Distinguished from the Local Polar Action," by Prof. W. J. Herdman, M.D., Ann Arbor, Mich. 5. "The Therapeutic Application and the Theory of Alternating Currents," by Dr. Georges Gautier, Paris, France. 6. "The Treatment of Fibroid Tumors with Electricity," by Dr. Georges Gautier, Paris, France. 7. "Induction Coils," by Mr. A. E. Kennelly, of the Edison Laboratory. 8. "Electrolysis in Tumors of the Bladder," by Robert Newman, M.D., New York. 9. "The Present Position of Electricity in the Treatment of Ectopic Gestation," by A. Brothers, M.D., New York. 10. "Electro-Therapeusis in Salpingitis," by W. B. Sprague, M.D., Detroit, Mich. 11. "Report of a Case of Ascites Cured by Galvanism," by Holford Walker, M.D., Toronto, Can. 12. The Primary Action of the Galvanic Current on the Blood. It Increases the Amount of Ozone It Contains as Shown by Chemical Tests of the Blood in the Arteries," by J. Mount Bleyer, M.D., and M. M. Weil, M.D., New York. 13. "The Conservation of Energy as a Successful Factor in Electrotherapy," by Horatio R. Bigelow, M.D., Philadelphia. 14. "Synovitis Treated by Cataphoresis," by F. H. Wallace, M.D., Boston, Mass. 15. "The Use of Static Electricity in the Treatment of Incipient Insanity," by W. F. Robinson, M.D., Albany, N. Y. 16. "Further Study of Anaesthesia and Frequency of Induction Vibration," by W. F. Hutchinson, M.D., Providence, R. I. 17. "The Absorption of Fibroid Tumors by Mild Electric Currents," by R. J. Nunn, M.D., Savannah, Ga. 18. "Some Observations on the Fine Wire Coil or Current or Tension," by H. E. Hayd, M.D., Buffolo, N. Y. 19. "The Treatment of Subinvolution by Electricity," by C. G. Cannaday, M.D., Roanoke, Va. 20. "Successful Treatment by Electrolysis of Four Additional Cases of Oesophageal Stricture with Exhibition of Two Cases," by D. S. Campbell, M.D., Detroit, Mich. 21. "The Treatment of Dysmenorrhoea by the Galvanic Current," by A. Lapthorn Smith, M.D., Montreal, Can. 22. "Notes Upon Some Uses of Galvanism in Surgery," by W. B. D. Beaver, M.D., Reading, Pa.

Several other papers of equal interest have been promised, but the titles have not yet been received.

Practical Aspects of Low Frequency Electrical Resonance.—V.*

BY M. I. PUPIN.

Various considerations led me to the conclusion that Foucault current and hysteresis losses were not the only causes of this remarkable diminution of the resonant rise due to the presence of iron. I will mention one only. In one of my experiments I used the primary coil of a small closed magnet circuit transformer for the inertia coil, and found that, as far as I could detect with my apparatus, no resonant rise could be obtained with 100 volts of impressed E. M. F., no matter how low the frequency was which my machine could produce. About 75 periods per second was the lowest frequency which I employed. If, however, the secondary coil of this transformer was short-circuited, then the resonant rise appeared, but not nearly as strong as it ought to have been, even Foucault currents and hysteresis losses taken into account. The self-induction of the primary (with secondary short-circuited), calculated from the capacity which produced resonance, was far too high. There were unmistakable evidences in this, and in all my other experiments in which iron was present in the inertia coils, that the lower the frequency the stronger were the resonance effects.

When an alternator giving 125 periods per second was substituted for the alternator in Fig. 7 (which gave about 350 to 375 periods per second), then the resonant rise with iron wire core in the inertia coil d was one-half of that when no core was used, the impressed E. M. F. being 45 volts. If, however, the impressed E. M. F. was raised, then this difference in the two cases continually diminished. When the impressed E. M. F. was 200 volts, then the resonant rise with iron was more than without it.

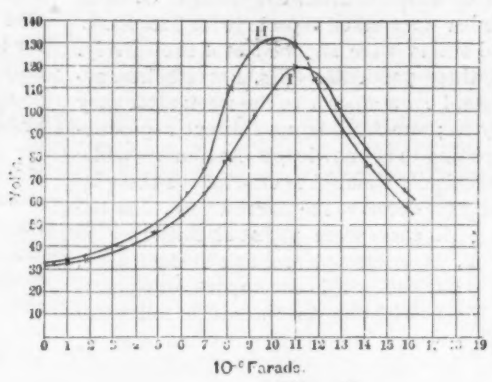


FIG. 12.

There seems to be in the iron a certain reluctance against getting into full swing when under the inductive action of a resonant current. The higher the impressed E. M. F. and the lower the frequency the easier it is to overcome this reluctance. When the iron has once been set into full swing, then it is possible by careful manipulation to lower the impressed E. M. F. and increase the frequency without getting the iron out of this swing. In a closed magnetic circuit this reluctance seems to be exceedingly great.

With a frequency of 50 periods per second the resonant rise with iron was invariably more than without it. Two features in the peculiar behavior of iron were brought out by the resonance experiments with this low-frequency machine. These two features, I venture to suggest, deserve more than ordinary attention.

The first peculiar feature is exhibited in the two curves, Fig. 12. Curve II. was obtained when the whole iron wire core (about 500 wires each 40 cm. long and 1 mm. in diameter) was inserted into the inertia coil. The other curve was obtained when only one-half of the core was employed. The frequency was maintained constant. From the critical capacity in the two cases it is evident that there was much less difference in the coefficient of self-induction in the two cases than one might expect from the difference in the quantities of iron, that is, if we suppose that in this case also the natural period of the circuit is independent of the frictional resistances due to magnetic hysteresis. But even if we drop this hypothesis, still the small difference in the capacity in the two cases appears as puzzling as ever. We have resonance in this case also as in any other case, but it is evident that the conditions of resonance are not determined by self-induction and capacity alone. The question arises then, what does resonance mean in this case? Well, it means the largest current and the highest rise of potential, but this maximum potential and current are not necessarily accompanied by zero difference in phase nor by neutralization of self-induction with capacity.†

The practical bearing of this result needs no further comment, especially when Dr. Duncan's more definite conclusions on this point are taken into account.

There is another point to which I wish to call your attention in connection with curves I. and II. of Fig. 12. It is this: Although curve II. was obtained with twice the quantity of iron and therefore, with at least twice the losses due to Foucault currents and hysteresis (since the magnetizing current which circulated in the inertia coil with resonance corresponding to curve II. was considerably larger than that corresponding to resonance of curve I.), yet the rise of potential in curve II. was larger than that in curve I. I do not wish to take up too much of your time in showing you all of the difficulties which one encounters in endeavoring to explain these matters satisfactorily. Suffice it to point out merely that these difficulties do exist and that they deserve our most careful attention.

Before making the next step in my discourse I wish to remark that a circuit consisting of the armature of an alternator, a large inertia coil without iron and a condenser, all in series, does not exhibit any of the peculiarities just mentioned, at any rate not to any considerable extent. Such a circuit can be tuned and a high resonant rise of potential can be thus produced, provided, of course, that this rise of potential is not accompanied by so heavy a current as to produce a serious armature reaction. Foucault current and hysteresis losses in the armature iron cannot, of course, influence this resonance, since they are taken care of by the motor which rotates the armature.

The second peculiar feature in the behavior of iron when it is under the inductive action of the resonant current of an inertia coil will be exhibited to you in the following experiment: The arrangement is just the same as that given in the diagram of Fig. 7, with the following exceptions: This alternating current ammeter is in the resonant circuit. The motion of its index, which I hope can be seen all over the room, will indicate to you the progress of tuning. I watch it on this side by means of a multicellular voltmeter which is denoted by f, in the diagram of Fig. 7. This four-pole 1-h. p. alternator which Dr. Laudy, of Columbia College, kindly lent me, takes the place of the 16-pole alternator. Inertia coil, alternator and condenser are all in series. The driving motor can easily take care of 2 h. p., so that the speed will remain constant during all variations of the load, since, as you will presently see, the load will never be over 150 watts. The condenser has now 16 mf. capacity plugged in. The frequency is about 50 periods per second. The impressed E. M. F. is 45 volts. To bring the circuit in resonance with the impressed E. M. F. it is necessary to insert iron wires into the inertia coil. I insert now about 400 wires. It is, as I can see from the voltmeter reading, considerably too much, and, therefore, there is no resonance, as you can see from the ammeter. I take the iron wire bundle and raise it slowly, and now I can feel by the pull on the bundle and also by the voltmeter reading that I have reached the point of resonance. You can see it by the ammeter deflection. The ammeter indicates one ampere; in reality it is about two amperes. (This instrument is a lecture room model and its reading must be multiplied by a large correction factor.) Now I lower slowly the iron wire bundle again; the resonance persists. I have reached now the same position from which I started and when there was hardly any resonance effect. But as you see this time the resonance effect is very strong. But it is a resonance which resembles very much a supersaturated zinc sulphate solution. A very small crystal thrown into such a solution will cause a sudden precipitation of innumerable small crystals. So it is with this resonance. If I now bring a single iron wire near the bundle, its mere approach upsets the resonance almost completely, as you see from the sudden drop of the ammeter needle. But if I add this wire whose mere approach upsets the resonance almost completely and even five other wires to the bundle and then by gently raising it start the resonant flow, I can then lower it again without disturbing resonance, as you see it from the deflection of the needle.

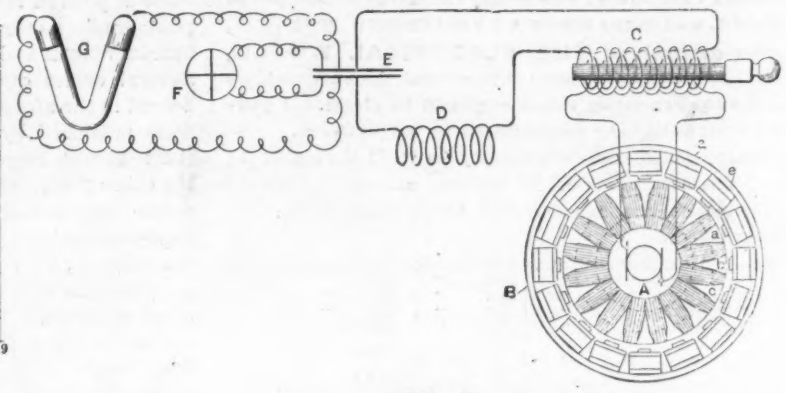


FIG. 7.

I shall vary now the capacity by taking out carefully one plug after the other. But I must take out these plugs without causing a spark. Here is one plug out and here another and four more. I have reduced the capacity by 1 mf. or nearly 7 per cent. of the total capacity. There is hardly any change in the resonance effect, as you see from the ammeter needle. Now I shall carefully put back the plugs, and even more than I have taken out, but carefully avoid sparking. As you see, resonance still persists without any apparent change. Now I take out one plug and vary the capacity by only 0.1 mf., but I take it out in such a way as to produce a strong spark by the removal of the plug. The experiment does not succeed. But here it succeeds at the removal of a 0.3 mf. plug. The collapse of the resonance effect is as you see almost complete. Generally I succeed with even less than a 0.1 mf. plug.

The same peculiarities appear also at higher frequen-

* For the preceding sections of this paper see The Electrical World of July 29, August 5, 12 and 19.

† Professor Duncan informed me yesterday that he arrived at this conclusion in a somewhat different way. See paper already referred to.

cies, but they are not nearly as clearly defined at frequencies over 100 as they are at those of less than 50 periods per second. They are certainly not due to any change in the speed of the machine, produced by the variation of the load due to the rise of the resonant current. Nor is it probable that they are due to armature reactions. This last point, however, deserves a closer examination than I have been able to give it as yet.

One more point I feel that I ought to mention before I end my discourse. It is a point which I think may have some practical importance sooner or later. When a large inertia coil without iron is joined in series with the armature of an alternator and also with a condenser and then the circuit is tuned, so as to analyze harmonically the shape of the impressed E. M. F. curve, I find in all the machines that I have tried so far that this curve is almost perfectly free from upper harmonics even with frequencies of 50 periods per second. If, however, the armature is closed by the primary of a transformer then upper harmonics will appear, as for instance, in the arrangement in Fig. 7. I do not think that these upper harmonics are entirely due to the variation of the permeability of the transformer core during each complete cycle, as has been suggested by very competent authority.* A different interpretation of the phenomenon is possible. My experience in this matter favors the view that the upper harmonics are due to the interference between the electromotive forces generated in the alternator and the transformer. I prefer, however, to devote more time to the examination of this exceedingly important subject before venturing to discuss the validity of this possible new interpretation.

Allow me now to sum up briefly the main points of this discourse.

The practical bearing of "Low Frequency Electrical Resonance" in so far as I have worked out the subject seems to rest on the following characteristic features:

It brings out very prominently the purely mechanical character of the phenomena of electricity, and it does that not by referring to carefully prepared delicate experiments of a skilled physicist, but by referring to phenomena which every electrical engineer can observe every day in the testing room, telegraph and telephone stations, and in central stations for power and lighting. A full appreciation of this purely mechanical character of the phenomena of electricity is of the greatest practical importance, for we must remember that the founder of this mechanical view, the immortal Maxwell, in opening this new view of electrical phenomena contributed to the advance of this science as much as, if not more than, any other investigator of this century.

It offers a new, simple, and exceedingly convenient method of transforming electrical energy from low to high potential.

It enables us to observe very accurately the behavior of dielectrics and of iron when under the inductive action of resonant currents, and thus to determine the exact limits within which condensers can be employed in the solution of electrical engineering problems.

It offers a new and exceedingly simple method (the method of harmonic analysis mentioned above) of studying the working of alternating current machinery under various conditions of load.

It points out a new and apparently very promising direction in which the difficult but exceedingly important study of the magnetic properties of iron can be pushed ahead.

In closing my remarks, I wish to thank my pupil, Mr. Milton C. Canfield, for the very efficient asistance he has given me in the preparation of this lecture.

* See Prof. Duncan's paper already cited; also H. A. Rowland, "Notes on the Theory of the Transformer," "Phil. Mag.," July, 1892.

MEMBERS OF THE INTERNATIONAL ELECTRICAL CONGRESS.

The Members of the International Electrical Congress.

On the last day of the International Electrical Congress at Chicago the members gathered on the steps of the Art Institute Building, in which the meetings were held, and were photographed. On the following day the official delegates were also photographed in front of Victoria House, in the World's Fair grounds. These photographs are here reproduced. Many well known faces will be found among both these groups. The official delegates contains some of the most prominent workers in the electrical field in the world, including such men as Helmholtz, Mascart, Rowland and Ferraris. In the large group of members most of the

BUDDE. SIEMENS. LEDUC. NICHOLS. WANNEMAN. THURY.
LUMMER. SCHRAEDER. DE LA TOUANNE. PALAZ. HOSPITALIER. CARHART. S. P. THOMPSON.
VIOLLE. PREECE.
FERRARIS. AYRTON. VON HELMHOLZ. MASCART. ROWLAND. E. THOMSON. MENDENHALL.

THE OFFICIAL DELEGATES.

official delegates will also be seen in the front, while the rest of the group is made up of those who attended the Congress as members, and includes a great many men who are widely known by their work in the field of electricity, both in this country and abroad.

Electric Traction in Germany.

Electric traction is being steadily developed in Germany, and is likely, within the next year or two, to make a good showing. There are roads running in Bremen, Halle, Gera, Breslau, Hanover, Dresden and Remscheid, besides the two old Siemens roads at Lichterfelde and Frankfort-Offenbach; and there are roads in course of construction or under contract in Breslau, Chemnitz, Dortmund, Essen, Lübeck, Nuremberg, Plauen, Hamburg, Gotha, Erfurt and Bochum. Wherever comparison has been possible electric traction has, as might be expected, proved its superiority over horse traction, particularly in respect of economy of operation and general excellence of service. For instance, on the Horn-Bremen section of the Bremen tramways there were in operation in 1891 six horse cars, and the gross receipts from May, 1891, to December of the same year, amounted to $16,935; these six horse cars were replaced in 1892 by five electric cars (the schedule time remaining the same), and the gross receipts for the corresponding period amounted to $20,700—showing an increase of $3,765, or 22 per cent. The total expenditure for the electric service over the above eight months came to $7,680, or 36 per cent. of the receipts. Similar satisfactory results have been recorded in Halle, as the following figures will show. The running expenses per car-mile with horses amounted in 1890 to 8.06 cents, while this figure was reduced upon the introduction of electricity in the following year to 5.78 cents—30 per cent. cheaper, therefore. At the same time the traffic receipts rose from 5.62 cents per car-mile in 1890 to 7 97 cents in 1891-92; and, instead of a deficit, as was the result of working with horses, a considerable balance to the good was obtained with electricity. These instances cannot be regarded as the mere accident of circumstances, because precisely similar experience has been had in Gera and other places where electric traction has entered the field. The most reasonable, and withal true, explanation is to be sought in the fact that the traffic increases proportionally as improved and increased facilities are offered.

The Tariff War Between Germany and Russia.

The electrical industry, so closely allied as it is in many respects to the iron industry, will be one of the chief to suffer from the result of the Russo German customs tariff war, for it will be easily comprehended that an increase of 50 per cent. in the import duties will simply prohibit the sale of German material in Russia. Cases are not wanting already even in which German firms have been obliged to withdraw from the field. In this connection it may be mentioned that the Allgemeine Elektricitaets Gesellschaft of Berlin have had an electric line running in Kiew for somewhat over a year, and, in view of the success which has attended its operation, they have lately received an order for the electric equipment of the entire tramway system there, covering about six and one-quarter miles of track with 24 motor cars. It will be interesting to observe whether, or how, this work will be affected by the new conditions, although of course it is possible that some special provision may be made in anticipation of the same, for the issue is no other than has been generally foreseen or expected for some time. The negotiations between the two countries had been pending, indeed, with intervals of abeyance, since the winter of 1890-91. The solution of this problem may, as suggested above, be awaited with interest.

Judging the Electrical Exhibits at the World's Fair.—II.

BY HERMANN S. HERING.

III. Lamp Tests.—(a) Incandescent Lamps.

Among the most important of all the tests will be those of incandescent lamps, and if they can be carried out as the committee desires, much valuable data will result.

The note on "Incandescent Lamp Tests," given in The Electrical World of Aug. 26, was the preliminary scheme proposed to the lamp makers several weeks ago. There have been a number of changes made in it since that time and the final scheme has not yet been decided upon, nor has the list of the exhibitors who have submitted lamps to be tested been completed. It is proposed to start the tests during the week of Sept. 4 and 9, if final arrangements can be made.

Below is given a general outline of the proposed tests, together with some descriptive matter of interest, as far as could be determined at the time of writing.

The lamps for the general test will be 110-volt, 16-c. p. lamps of the 3½-watt class for direct currents, and 50 volt, 16-c. p. lamps of the same class for alternating currents. A special test will be made to obtain the relative behavior of 100-volt and 50-volt lamps for alternating currents of the same make and class.

The principal results that are desired are: The initial candle power and efficiency; the life of the lamps; the variation of candle power and efficiency with the life of the lamps, and perhaps the cost of a candle-power-hour at different intervals throughout the life of the lamps, provided an agreement can be reached on that point.

A laboratory for carrying on the tests has been equipped on the ground floor in the southwest corner of Electricity Building. No provision had been made for any of the

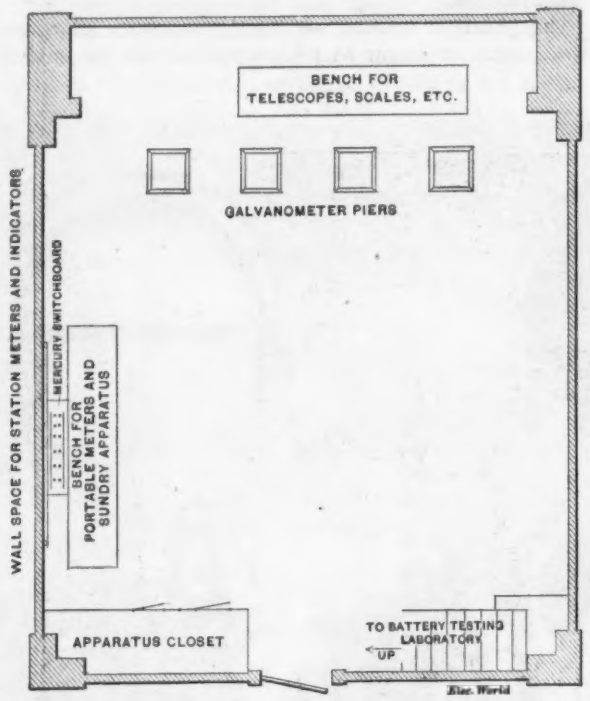


Fig. 6. Plan of Instrument Testing Laboratory.

laboratories until the judges assembled in July and the delay in obtaining rooms and supplies caused by the officials at headquarters, together with the difficulty of reaching an agreement with the lamp exhibitors, has seriously inconvenienced the judges, and may result in the tests being foreshortened.

Fig. 1 shows a general view of the laboratory as seen from the aisle. Fig. 2 is a plan of the laboratory showing the general location of switchboard, lamp racks, photometers, etc. Fig. 3 is a view of the photometer and switchboard, taken from the door on entering the laboratory.

The lamp racks, five in number, are substantially built and are wired for about 450 lamps; two racks for 110-volt direct current lamps, two for 50-volt alternating current lamps, and one for 50 and 100 volt alternating lamps for special tests. Wires run from the switchboard to each rack and branch off at the various shelves. All the wire used up to the sockets is between No. 00 and No. 0000, B. & S. gauge, so that the drop will be negligible and all the lamps at a uniform pressure.

The switchboard contains the rheostats for controlling the pressure of the currents supplying the lamps, direct and alternate pressure indicators, and the necessary switches for operating the circuits. On the bench in front of the switchboard are the Weston standard ammeters and voltmeters, which will be used in taking the readings. Three Thomson transformers are used and are placed under and behind the switchboards.

The current for the duration tests will be supplied by the Fort Wayne Electric Company from their exhibit, and from machines that will be used exclusively for this purpose, and they will be controlled by the judges making the tests.

In Machinery Hall a Buckeye engine drives a 15 h. p. direct current generator, from which special wires run to a motor in Electricity Building. This motor drives a direct and an alternating current dynamo, wires from which run to the switchboard in the laboratory. Both the field and the current of these machines are controlled from the switchboard in the laboratory. These arrangements, it is hoped, will enable the judges to obtain an unvarying pressure at the lamps.

The current for the efficiency tests will be supplied by the Pumpelly-Sorley Storage Battery Company.

Rheostats and switches are arranged in the laboratory so that any voltage may be obtained and the lamps tested at the exact pressure for which they are rated and under practically constant conditions. This voltage will be the same as that on the rack, but storage batteries are used, as they give a practically steady current.

Measurements will be made in somewhat this order:

The new lamp is tagged and placed in the photometer, run at its proper voltage, and simultaneous readings taken of the current, voltage and candle power, the method being described in greater detail below. This gives the initial performance. It is then placed in the rack, the time of starting noted, and run for 10 hours or more, after which it is again placed in the photometer and the readings of the candle power, current and voltage made again, and so on until the lamp breaks. After running a lamp several days the readings will be taken less frequently, perhaps only once a day. Several readings will be taken at each observation, and the mean taken as the value for that point. The tests will continue day and night, except Sundays, until Oct. 1, or perhaps later.

The photometric measurements have naturally been the cause of a great deal of consideration, but the difficulties have mostly been adjusted and the apparatus made ready for final work.

The photometer is the Lummer-Brodhun design, made by Schmid & Haensch, Berlin, and exhibited by Eimer & Amend, of New York.

The form which is made by Queen & Co., of Philadelphia, is quite similar to the one used by the jury in these tests.

A screen of gypsum is illuminated by the two lights to be compared; each side is reflected by a mirror through the prisms, the light from the side of the gypsum screen passing through the prisms and the light from the other being reflected, so that both can be seen in the telescope, the arc as a circular disc, the other as a surrounding annular one, the line between being sharply defined. The arrangements of prisms is interesting: two right-angled prisms have the hypotenuse ground perfectly plane and pressed together, one surface being smaller than the other, so that the light from one mirror passes through the portion where both prisms are in contact, and that from the other is totally reflected by the portion of the rism where there is no contact with the other prism. The scale upon which the carriage moves is 250 centimetres long, and the photometer is sufficiently sensitive to detect an alteration in position of 1 millimetre.

The standard of illumination will be the English sperm candle burning 120 grains per hour. A number of these candles have been imported for this work. These will be used in calibrating a Methven screen, which Prof. Thomas has been using in his laboratory for some time.

The lamp of the Methven standard will be supplied by ordinary city gas passed through a Wright carbureter and thoroughly saturated with pentane vapor. The pressure will be kept constant by means of a sensitive pressure regulator loaned by Messrs. Ewart & Son, London.

On account of the difference in color of the Methven light and the electric light, and the greater amount of time required to make the comparisons, several incandescent lamps will be compared frequently with the Methven lamp and used as the working standard throughout the tests. These lamps will be of 32 c. p. and a slightly higher voltage than the lamps tested, so that they will run below their normal candle power when on the standard voltage.

The reflection of the filaments in the lamp bulb has been a source of much annoyance, as it gives a false value for the illumination of the filament. At a test made of the effect of the reflection of the Methven light in the glass chimney, it was found that with the rear half of the chimney blackened there was a decrease in illumination of 9 per cent. As the Methven lamp is compared with standard candles this makes no difference, as it was merely desired to investigate the amount due to reflection. As this cannot be remedied in the incandescent lamp bulbs, it will be disregarded, except in so far as it produces no great variations at different positions. The method to be used is to take horizontal readings of candle power of the lamp at the outset, with the lamp rotated at different positions on a vertical axis; from this the mean horizontal intensity will be obtained. The position of the lamp corresponding

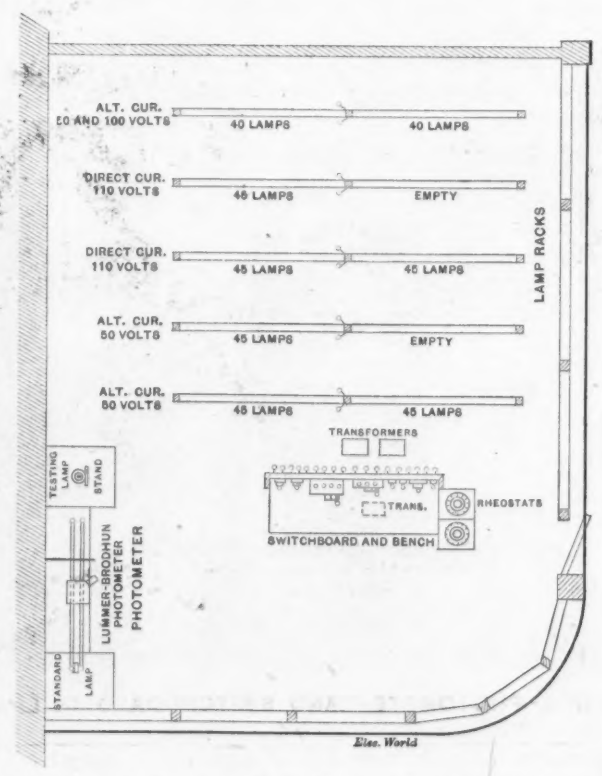


Fig. 2. Plan of Lamp-Testing Laboratory.

to this mean, and that at which a turning of five degrees produces no alteration in candle power, will be the position of the lamp at which it will be tested thereafter, a mark being made on the base of the lamp. All of the lamps will be treated in this manner at the beginning of the test. Several students of the Ohio State University have been arranging the laboratory under the direction of the judges, and will assist in conducting the tests.

(b) Arc Lamps.

Examinations for award will be made of the arc lamp, but no decision has been finally reached about the tests. It is proposed, however, to test the sensitiveness of regula-

tion, regularity of feed, promptness of cut-out mechanisms and in general the perfection of mechanical arrangements. If time will permit, the candle power and efficiency will also be determined.

The lamps furnished for the tests are the ordinary type for direct and alternate currents, and for constant current and constant potential, and also some search lights.

The quality of the carbons and the illumination will be investigated if time will permit.

The Schuckert search light has already been tested, the illumination being determined by means of a photometer placed at certain distances, and the current and potential determined simultaneously. Other search lights may also be tested, but no decision has yet been reached.

Much interesting and valuable data could be obtained by complete comparative tests, and it is hoped that the judges will be enabled to carry out their plans. Owing to the postponement of the work of preparation until so late in

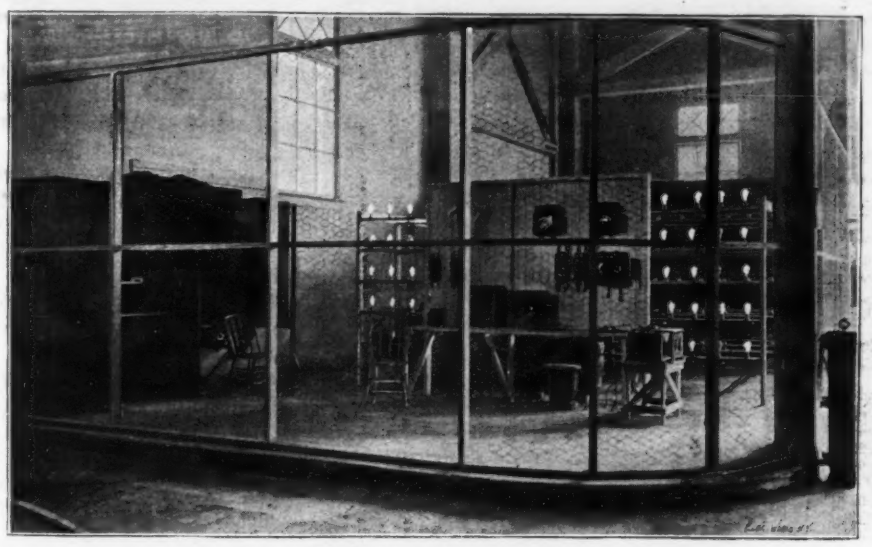


FIG. 1.—LAMP TESTING LABORATORY.

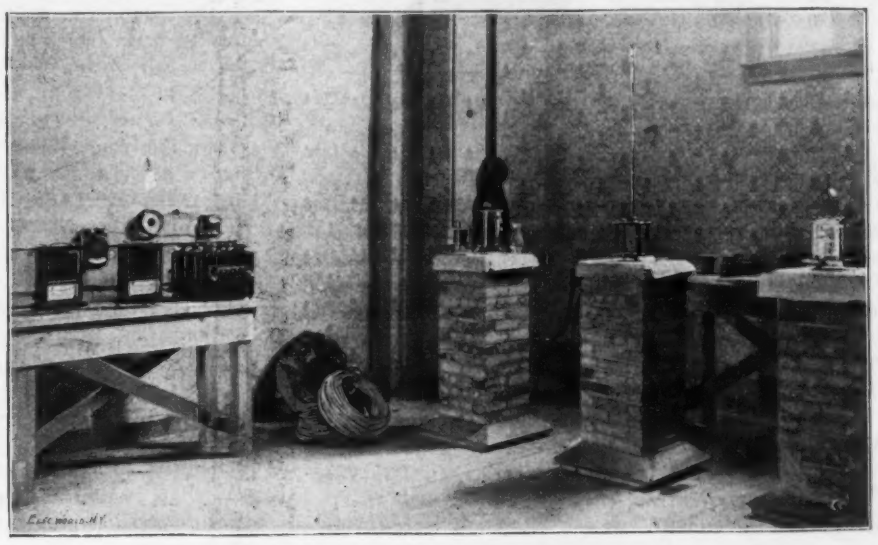


FIG. 5.—INSTRUMENT-TESTING LABORATORY.

the season, and the great delay experienced in obtaining accommodations and supplies for the laboratories, and to the very short time remaining, it is very doubtful if very much will be done, unless the tests be continued some months longer.

IV.—Battery Tests. (*a*) *Primary Batteries.*

The cells submitted for tests are of a large variety of forms, but mostly of the Leclanche and dry cell type and a few for constant current.

They will be tested for initial voltage and internal resistance, and the cell will then be short-circuited with a resistance of about two ohms for half an hour and determinations made of the rate of output, polarization and recovery. No tests will be made of efficiency of primary batteries.

Readings will be taken of the P. D. on open and closed circuit and the currents at frequent intervals, and the internal resistance calculated from these in the usual way.

Two ohms was decided upon for the external resistance because the committee believed that the circuits upon which the batteries were usually operated in practice averaged about that resistance. Five ohms, the resistance generally used, was thought to be too high.

A laboratory, Fig. 4, has been fitted up in the northwest corner of the Electricity Building, second floor, for the work of battery testing. The work is well under way and will soon be completed. The instruments used are Weston standard ammeters and a large Weston laboratory standard volt-meter; also some Queen testing sets for measuring the resistances of the circuits, and sundry apparatus. A mercury switchboard has been arranged by which the connections can be made rapidly and conveniently.

The following batteries have been submitted to be tested:

Union Electrical Works, constant current.

Hanson Battery Company.

Wm. Burnley, cartridge battery.

Greeley & Co., Exeter dry battery.

Gardner & Sons, Standard dry battery.

Western Electric, Phœnix dry battery.

Western Electric, Pony dry battery.

General Electric Company, Limited, dry battery.

Queen & Co., iodide cell.

Vetter & Co., Leclanche cells.

Leclanche Battery Company, Leclanche cells of various types.

H. Schonberg & Sons, dry battery.

S. S. White Dental Manufacturing Company, Partz motor batteries; Partz acid gravity batteries; Leclanche cells.

Domestic Electric Power and Light Company, primary battery.

(*b*) *Secondary Batteries.*

No decision has been reached regarding the tests of storage batteries, and so no definite information could be obtained. There are not more than half a dozen makes of batteries submitted, and the principal tests will be the efficiency at various outputs, the capacity in ampère-hours, weight, etc. The special class of work for which the batteries are adapted, as well as the claims of the makers, will be carefully considered while making the tests.

It has not been decided at what time these tests are to begin.

V.—Tests of Measuring Instruments.

A view of a portion of the laboratory for instrument testing is shown in Fig. 5, and a plan of the same in Fig. 6. This room is located on the ground floor in the northwest corner of the Electricity Building, and contains four brick piers, well built to prevent vibrations, a stand for telescopes, scales and apparatus, and a bench and wall space for the tests of the ammeters and voltmeters. A mercury switchboard has been arranged to facilitate the tests. Current is supplied from storage batteries.

The equipment of this laboratory has progressed with great difficulty, owing to the lack of facilities given by headquarters, and it has been put in partial order after five weeks' delay, which will seriously affect the completion of the tests, as many of the judges will be compelled to leave. The following tests are suggested:

(*a*) *Galvanometers.*

The galvanometers submitted for tests are:

Queen & Co., high grade Thomson galvanometer.

Queen & Co., new D'Arsonval form.

Hartman & Braun, astatic.

Greeley & Co., Thomson form.

Western Electric Co., Thomson form.

All of these are high grade instruments of 10,000 ohms resistance and represent the best work of the makers.

These will be tested for sensibility under similar conditions, the value to be given as the current required to cause a deflection of 1 millimetre at a distance of 1 metre from the mirror. The results will be reduced to the same periodic swing, the readings being taken when the controlling magnets are so placed as to make the time of swing practically the same for all the galvanometers.

The general design and construction will be critically examined and reported upon. Special attention will be given to the protection of the moving system and the facility of replacing suspension and getting at the coils.

This work has been almost finished.

(*b*) *Resistances.*

Resistance boxes of different makers will be compared with one another and also with a standard ohm. The various standards will also be compared with each other, the new Cavendish ohm being accepted as the standard.

This work is well under way and the results indicate a remarkable agreement among the various makes.

These tests are being made at the Armour Institute, as there were no facilities offered at the Exhibition.

(*c*) *Standard Cells.*

Comparisons will be made of the various standard cells and the absolute value and temperature coefficients determined from the English standard Clark cell, according to the Board of Trade definition. No definite arrangements have been made, but it is probable that the following cells will be submitted for tests:

Weston Elect. Inst. Co.; Standard Elec.; Queen & Co.; Carhart-Clark cell; Western Electric Co.; Muirhead-Clark cell; the Clark cell of the Physikalisch-Technische Reichsanstalt.

(*d*) *Commercial Meters.*

Tests are to be made of commercial ammeters, voltmeters, wattmeters and electro-dynamometers.

They are to be compared with one another and with the instruments of the Weston Electric Inst. Co., which are temporarily taken as standards, and subsequently standardized absolutely. In the case of ordinary station instruments no great accuracy is required.

Readings will be taken first on an ascending scale and then a descending without breaking the current, in order to determine the magnetic lag. Station instruments will be allowed to run until they are heated normally before readings are taken.

The alternating current instruments will also be tested under various frequencies.

In addition to accuracy and lag, tests will be made of the dead-beat qualities of the instruments and their power to measure promptly any sudden changes in the current or pressure. This latter is an important matter.

Wattmeters, in addition to being operated at various frequencies, will be tested with varying current and voltage and their accuracy determined under those conditions.

Notes.—Profs. Mendenhall, Ryan, Thomas and Pope have been appointed to constitute Sub-Committee No. 8.

Profs. Ayrton and Rowland have left, the former for London and the latter for Seal Harbor, Me.

Prof. Mendenhall has been appointed chairman of Sub-Committee No. 1 to succeed Prof. Ayrton.

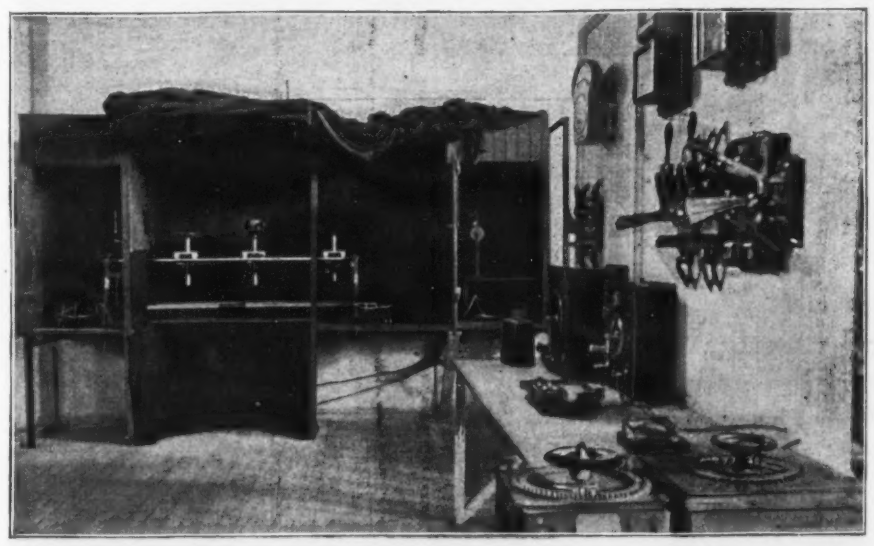


FIG. 3.—PHOTOMETER AND SWITCHBOARD IN LAMP TESTING LABORATORY.

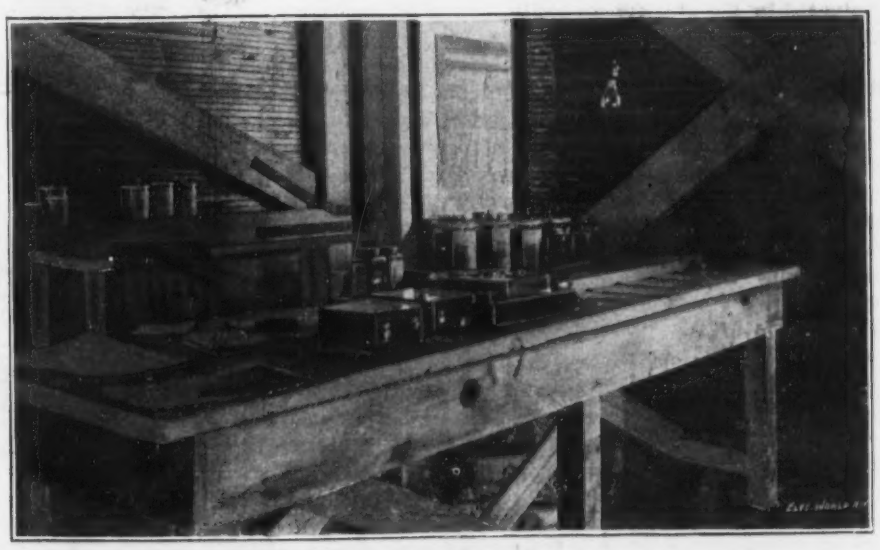


FIG. 4.—BATTERY TESTING LABORATORY.

THE ELECTRIC APPLIANCE COMPANY.

The Electric Appliance Company, of No. 242 Madison street, Chicago, make a most interesting composite display in the southwest gallery of the Electricity Building. Like another company, whose display was recently described in these columns, the Electric Appliance Company is the agent for quite a number of the leading manufacturers of electrical supplies, among which may be mentioned the following:

The Whitney Electrical Instrument Company, Boston, Mass., manufacturers of voltmeters, ammeters and indicators for direct and alternating currents; New York & Ohio Company, Warren, O., manufacturers of the Packard lamps; Indiana Rubber and Insulated Wire Company, Jonesboro, Ind., Paranite wire; The Electric Construction Company, Elkhart, Ind., Elkhart transformers; Von Cleff & Co., New York, linemen's instruments; The Emerson Manufacturing Company, St. Louis, alternating current motors; Iona Specialties, sockets, cut-outs and switches; The Consolidated Electric Manufacturing Company, Boston, Mass., C. E. M. jack-knife switches; O. S. Platt, Bridgeport, Conn., New England (double pole snap) switches; W. A. Vail, swinging ball lightning arresters, and Phillips Insulated Wire Company, O. K. weather proof wire.

Exhibits of all these manufacturers have been tastefully arranged by Mr. F. S. Gassaway beneath the unique canopy of different colored lamp cord, supported upon a light frame of gilded rods. This lamp cord is some of the first ever made by The Indiana Rubber and Insulated Wire Company, and has therefore a historical interest. It has also been arranged with highly artistic effects as the cords in their graceful catenaries produce a very pleasing architectural effect of the Oriental type. One hundred and twenty-three miles of this cord, according to Mr. Gassaway's measurement, is employed in this structure, and the airy appearance of the display is accentuated by the atmosphere set in motion by numerous Meston alternating current fans.

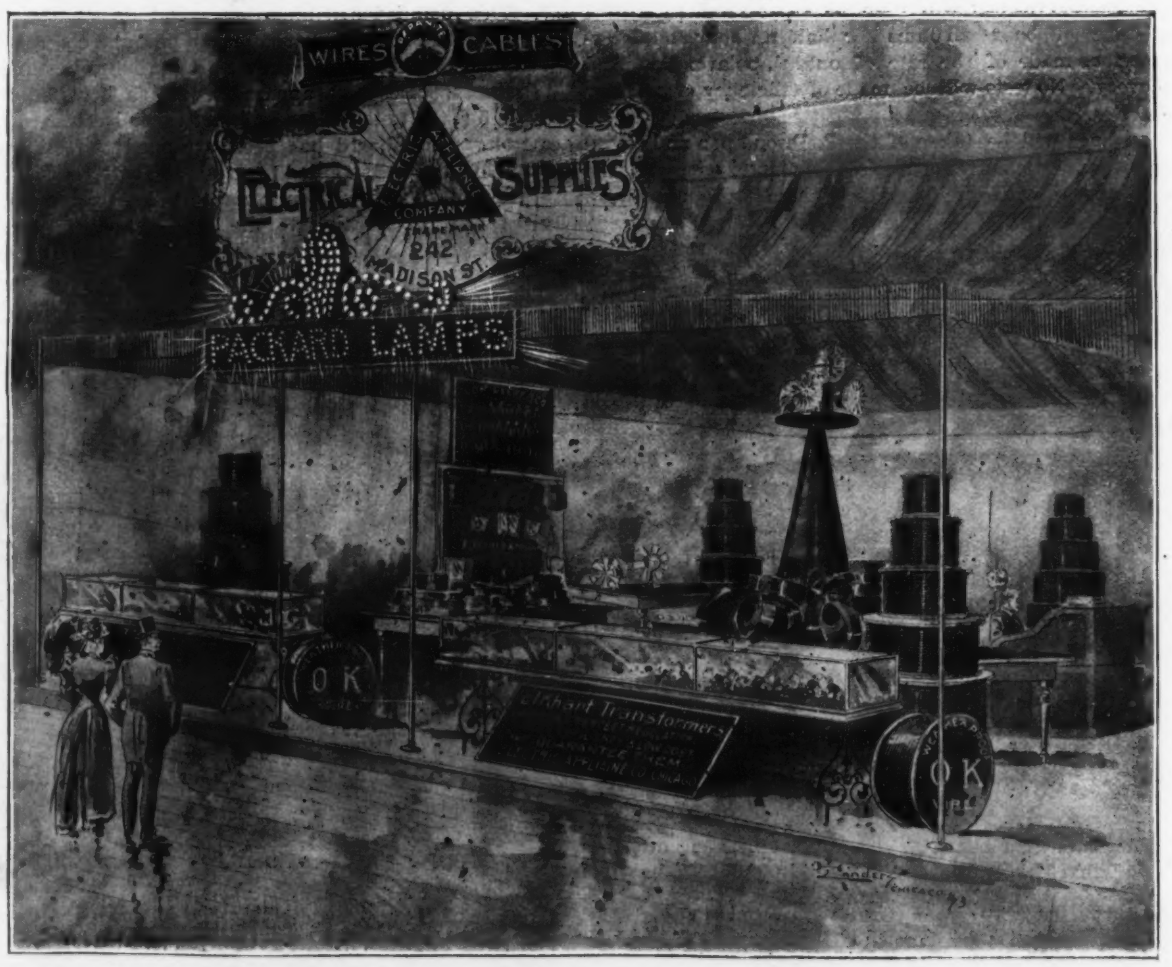
The space assigned to this company extends between the main aisle and that overlooking the ground floor, from both of which it is entered through a low railing by means of gateways. To the south of the west entrance is a large showcase containing three 50-c. p. Packard lamps, which are continuously illuminated. Thrown in around these in careless confusion are multitudes of the same make of lamps in all colors, with both molded and blown bulbs, in sizes from 6 to 50-c. p. each. To the north of this entrance is another similar showcase, in which are displayed the C. E. M. jack-knife switches, varying from 15-ampere single and double pole motor switches to three-pole 350-ampere switches. Above the entrance is the Paranite trade-mark, and below this the trade-mark of the Electric Appliance Company. Directly over the gate, on a scroll, in handsome letters, are the words "New England Switches." On either side of the east entrance there are also arranged showcases; that to the south displaying Whitney's volt and ammeters for both direct and alternating currents. In this case, also, is a special commutator driven by a Meston slow geared alternating current motor, which controls the lamps in the lamp sign directly over the entrance, to be described presently. The other case, to the north, is filled with Packard lamps of different designs and all colors, both molded and blown, arranged in groups and tasteful clusters. Spanning the doorway is the great Packard lamp sign, which is one of the unique and special features of the Electricity Building. This is composed entirely of 50-volt 6-c. p. lamps, which by the way are claimed to be the lowest candle-power lamps for regular voltage ever made in this country. These spell out in large crimson letters the name "Packard Lamps," which, by means of the commutator before referred to, are illuminated and extinguished, letter by letter, until each word has been thus spelt, and then the whole word is flashed at once. Thus, as one looks at the sign, he sees it spell out P-A-C-K-A-R-D, PACKARD; L-A-M-P-S, LAMPS; PACKARD LAMPS. This never fails to arrest the attention of the passer-by within reach of the rays, and has proved an invitation to visit the gallery which few of the curious can resist. Over this sign is a handsome scroll-work, the centre in white and orange, and extremities in blue. There are in all 342 lamps in this sign and scroll work. Above the illuminated sign there is another, bearing the name of "Paranite"; beneath it the words "ELECTRICAL SUPPLIES," together with the familiar trade-mark of the Electrical Appliance Company. On the floor on either side of the east entrance are other handsome signs, that to the northwest bearing the legend "The Elkhart Transformer," and that to the south calling attention to the Whitney volt and ammeters.

The four corners of the space are occupied by pyramids of reels of Paranite wire, each consisting of five reels, showing wires taped, braided and plain, varying in size from No. 0 to No. 14, styles suitable for all interior concealed work, and other situations where great safety and high insulation are prime requisites. Placed diagonally across the corners in front of these four pyramids are four simple tables with blue cloth covers, upon which the following displays are shown:

The southwest table had a line of Meston alternating current motors, especially wound for the Westinghouse Company, 7,200 period current. Some of these are shown in operation with fans attached, and have been found to work satisfactorily in every way. The Meston alternating current motor is, as most of our readers know, one of the best known and most successful motors adapted to alternating currents. Its interior mechanism is not popularly known for the reason that the motor is self-contained within a metallic case, which prevents the inspection of the curious. It will be found to be exceedingly simple, however, in construction, and may be described briefly as follows: The armature is of the hourglass shape, and is built up of laminated iron and without windings. The two carbon brushes imbedded in recesses in this armature are pressed out against appropriate contacts on the frame by coiled springs within. One of these contacts is merely a collector ring on the reverse side of the motor case, and the other is a segment commutator on the front. The field magnets are six in number connected in parallel, and are so connected with the commutator segments in advance and cut out in the rear of the brushes themselves that the action may be said to be that of a rotating field, which drags the soft iron armature around with it. The direction of motion is controllable by means of a simple switch which, in its central position, throws the current off, and in either of the other two positions throws the fields either to the front or the rear into action.

The northwest table is covered with 50 and 100-volt regular alternating motors of this same type in different designs, intended for special classes of work. One of these, a ⅛-h. p. motor, provided with slow speed gear, is fitted to a small dental drill, the regulation being by means of a treadle. It is mounted on neat tripod feet finished in black, enamel and gilt. All the brass parts are heavily nickel plated and extra finely finished. It is provided with a convenient attachment for lifting and moving about, and the whole apparatus complete weighs but 30 pounds. The motor gives a speed, variable at will by a slight pressure upon the foot lever, of from 150 revolutions per minute to 2,500, and at any of these speeds can be instantly stopped or reversed. The stop brake acts mechanically, and when applied automatically cuts off the supply of electricity, thus avoiding the waste of current and the danger of burning the field coils. The standard may be adjusted to any desired height, as occasion may require, thus it would seem supplying all the requirements of a perfect dental engine.

The northeast table is occupied by coils of Paranite wire and souvenir calendars containing samples of this same wire. The Paranite, as is well known, is one of the new or comparatively new wires, but during its brief existence before the public has become very popular where exceedingly high grade material is desired.



THE DISPLAY OF THE ELECTRIC APPLIANCE COMPANY.

On the southeast table are shown coils of various sizes of O. K. weather-proof wire artistically arranged.

At the middle of the south line of the Electric Appliance Company space stands one of the supporting pillars of the roof. Upon this are hung, one above the other, two large sample boards; the uper one of oak covered with cloth contains the exhibit of Von Cleff & Co.'s goods, which, as before stated, comprises linemen's tools of all kinds. These are tastefully arranged, and the polished steel of their brighter parts makes a pleasing contrast with the matted black of the cloth behind. Upon the lower one, which is a mahogany board with a shelf on its lower edge, are shown

Whitney electrical instruments and indicators, as follows: Upon the upper left hand corner is a potential indicator of 110 volts, and on the upper right hand corner a current indicator for 200 amperes. In the centre line on the left is a voltmeter reading to 15 volts, and on the right an ammeter reading to 10 amperes. Between the two is another ammeter reading to 600. In the lower left hand corner is a double scale, alternating current voltmeter, the upper scale of which reads to 150 volts, and the lower one to 75. On the right is a portable alternating current ammeter reading to 24 amperes. On the shelf a voltmeter reading to 750 is placed between a double scale voltmeter on the left for direct currents, the upper scale of which reads to 150 and the lower scale to 15, and a direct current ammeter reading to 100 on the right.

A similar post is conveniently located on the north line of this company's space, and upon this is hung an oak sample board of the Iona specialties, including switches, cut-outs, sockets and electric gas burners.

In the exact centre of the floor there has been erected a cone eight feet high, wound with the celebrated Paranite wire, commencing at the apex with No. 18 B. & S., and ending near the base with 0000 lead covered conductor. Below this is a coil of 37 conductor aerial cable, and one of 10 conductor submarine armored cable, this latter being a part of the first cable of the kind made by the Indiana Rubber and Insulated Wire Company. The apex of the cone is surmounted by a narrow capital or disc of cloth covered wood upon which are placed four stationary Meston fans, and elevated above these at their centre a single revolving fan of the same make.

Just south of the pyramid is a small table of New England double pole snap switches, of capacities ranging from 10 to 100 amperes. These are shown assembled and in their detached parts. Still further to the south, and outside of the southern pillar above referred to, is shown the display of the Electrical Construction Company, of Elkhart, Ind., which consists of three Elkhart converters in operation. Upon the south side of this post has been erected a Wright double pole transformer cut-out of the Hope Electrical Appliance Company, Providence, R. I., make. Into this is led the 1,000-volt, 7 ampere current furnished by the Ft. Wayne Company, on the main floor beneath, and from it lead circuits to two 75-light, 50-volt and one 30-light, 100-volt Elkhart transformer. The current issuing from the 50-volt transformers supplied the three 50-c. p. lamps mentioned in the early part of this article in the case to the south of the west entrance, together with the 342 lamps in the lamp sign over the east entrance, and it is used in some of the special motors, and the 100-volt current is used for the regular fan motors.

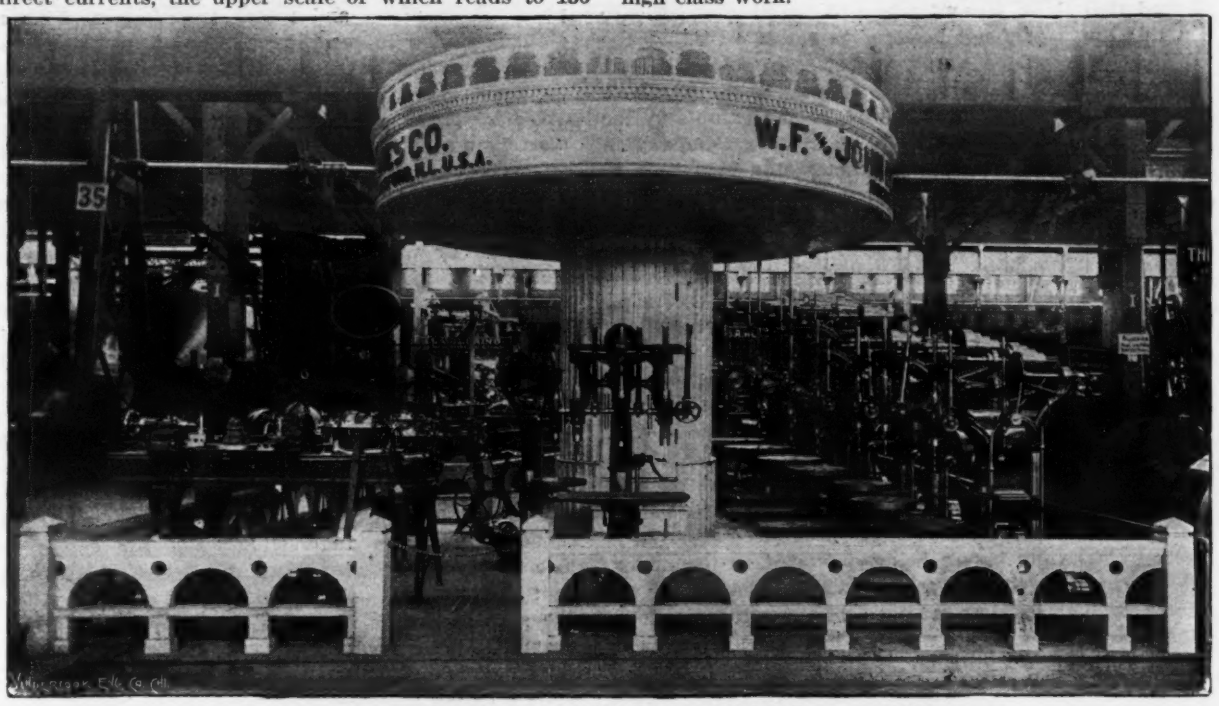
THE W. F. JOHNS BARNES EXHIBIT.

Among the interesting exhibits in the beautiful Machinery Hall is that of the well known firm of the W. F. & John Barnes Company, Rockford, Ill. Their location is at the southwest corner of the fountain square, Section 14, Column J—36.

In the centre of the space occupied by the Barnes company they have erected a graceful turret, from which there is a fine bird's-eye view of Machinery Hall.

The exhibit is in charge of Mr. J. E. Putnam, of the Barnes company's office, and all visitors will be welcome.

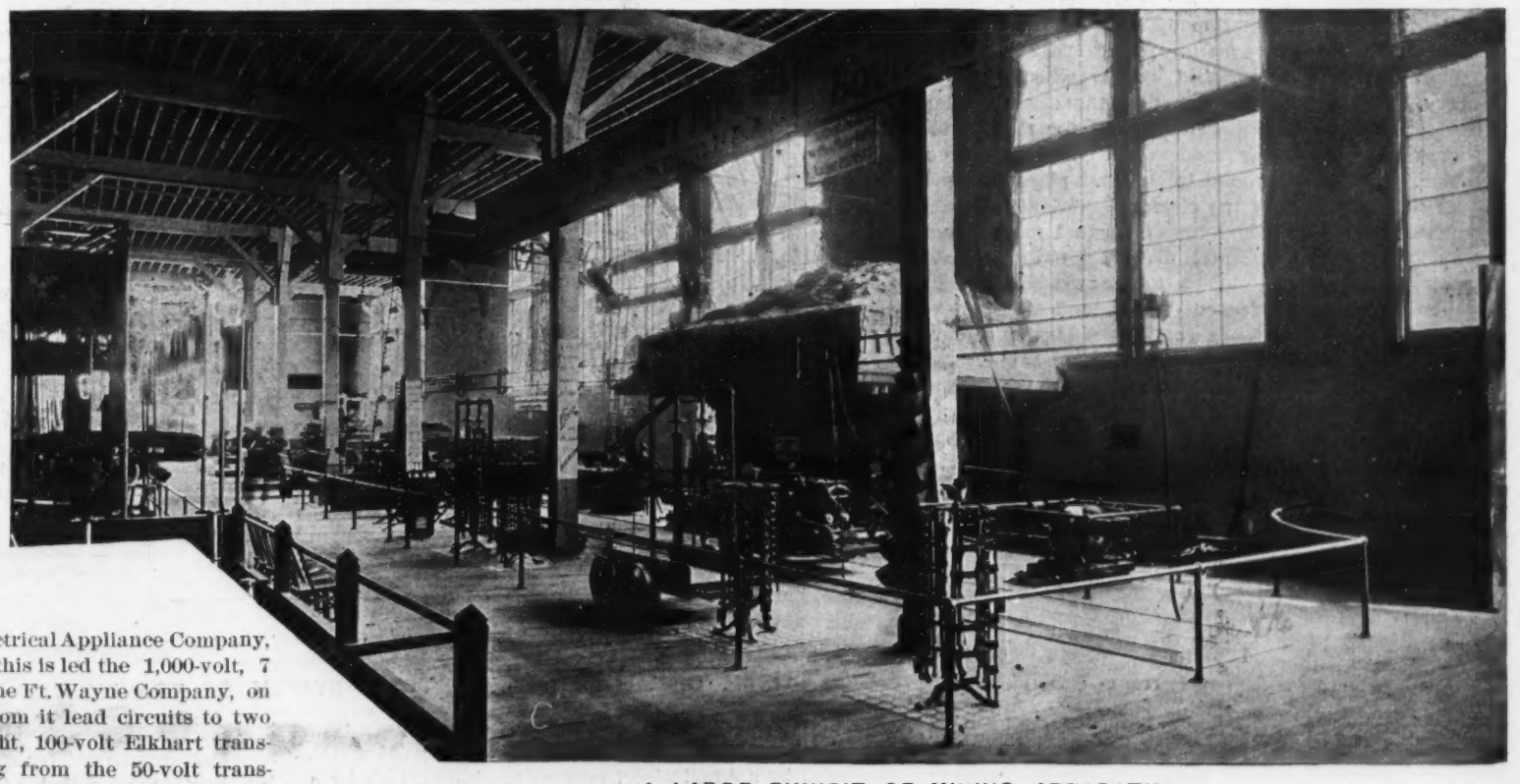
The exhibit is an extensive and interesting one, and embraces a full line of the machines made by this company, and which have made their name familiar in all parts of the world. The machines shown comprise a very full line of drill presses, lathes and other machine tools for metal work, and also a line of hand and foot power machines for wood workers' use. The line of drills covers a wide range from a friction driven drill for light work up to a 42-inch back geared drill for heavy work in railroad shops and large manufacturing establishments. A three-spindle drill was also particularly noticed, a tool which has acquired great popularity in bicycle factories, and is especially adapted for high class work.



AN INTERESTING COLLECTION OF MACHINE TOOLS.

The line of small screw cutting lathes made by the Barnes company is, without question, one of the very finest on the market, and the superior quality and reasonable prices of these tools have made a world wide market for them. The Barnes company state that they will ship between one and two hundred lathes this year to England alone, and they are making frequent shipments to Australia, South America and other parts of the world.

One of the interesting machines shown is a new friction driven lathe, in which a friction driving device takes the place of the cone pulley. It is a radical departure from old forms of lathe construction, and the results obtained show that the new tool has distinct and marked advantages in increased efficiency, as compared with lathes of the ordinary type. It would be quite impossible to mention in the space at our command the different machines made by this company, and we must be content to urge those of our readers who visit the great Exposition not to overlook this exhibit of the Barnes company, which is in many respects as interesting as anything to be found in Machinery Hall.



A LARGE EXHIBIT OF MINING APPARATUS.

THE JEFFREY MANUFACTURING COMPANY.

Situated in the northeast section, ground floor, of the Mines and Mining Building may be found the extensive exhibit of the Jeffrey Manufacturing Company, of Columbus, O., who are acknowledged to be authority on machinery for mining and handling coal.

This company was organized in 1877, and has bent all its efforts toward the best and most economical methods of coal mining. Their space in the Mining Building comprises 1,500 square feet of floor, on which they have placed samples of their mining machinery. Their exhibit might properly be divided into two parts: first, the mining department, in which they show the Jeffrey electric and air power under-cutting machines, electric, air power and hand rotary coal drills; electric pump, electric truck, dynamo, etc.; while in the other or second department they show complete handling devices for the elevating, screening and conveying of coal. To better show the position and conditions under which their machines operate, they have erected an imitation coal bank, showing the formation and strata of an ordinary coal vein, and by this ingenious arrangement they have made it possible to display their machines in actual operation. Seeing the advisability of being able to show operators and those interested in coal mining machines at work, they made arrangements with the Exposition authorities, at considerable expense, whereby they might have ample amount of power continuously at their service.

To more clearly describe the coal-cutting department of their exhibit, we beg to go over in detail some of the machines here shown. On a suitably arranged track extending the full length (60 feet) of their space is a truck bearing a complete electric mining machine, which is connected to the trolley system of their own construction, by means of which they are able to move mining machines with perfect ease. This device is shown to demonstrate the simplicity and ease with which the machines may be moved from one room to another in mines, after the machine is through making its cut and is ready to be moved to another room. At one end of track is a movable electric pump on a truck, which is admirably adapted to the purpose of pumping water in mines from dipping rooms or entries. To prove the practicability of this pump, the Jeffrey Manufacturing Company has placed a tank under the floor, and by means of suction and discharge hose can keep a constant stream passing through the pump. Fastened to the roof of their mine they show an electric drill in operation, while along the front of the space on racks may be found both positive and air-feed coal drills, which are operated by compressed air, as well as several different patterns of hand drills.

Located below the floor at one end of their space is a cast iron boot, from which, to the gallery above, extends to a single chain elevator with malleable iron ore buckets placed about 24 inches apart. This elevator discharges into a revolving screen hung from the gallery, which is constructed in a substantial way, and is covered by three different meshes of steel wire in order to make the proper separations of the coal. At the end of the screen, opposite to the elevator, the material is discharged into a drag conveyer, and from this conveyer the material is delivered into a hopper, which, in turn, delivers it onto a picking table, and from there, by means of a screw conveyer, it is returned to the boot. All these devices are in continuous motion and running in unison, the material which they handle being constantly passed from one device to another.

The company has also on display a large number of the different sizes and styles of chain belting for all conceivable purposes, such as conveyers, elevators, driving belts, etc.

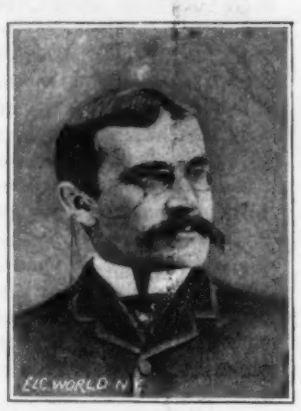
In charge of this exhibit are men who are practically acquainted with their departments, and able to give information and useful hints to all who may be interested.

They have, also, a large collection of blue prints of drawings showing special designs, which are of interest to operators.

Multiphase Motors and the Transmission of Power

A QUESTION so important as the long distance transmission of power had been apparently overlooked in the preparations for the recent International Electrical Congress, as no papers on this subject appeared in the programme, and this fact excited more or less comment. When it was understood that the matter would come up for consideration in the section of Pure Practice, over which Prof. E. J. Houston presided, it was evident that the discussion would be followed with great interest, and that the attendance in Section B during that time would be very large. The idea, it is stated, originated with Dr. Louis Duncan, of Johns Hopkins University, who has always taken an active interest in this question, and is regarded as one of the leading exponents of the transmission of power by alternating currents in this country.

On Thursday forenoon the chairman of Section B accordingly called upon Dr. Duncan to open the discussion, and as many points of great value and interest were brought out it is given below in more detail than the brief synopsis which appeared in the report of the proceedings of the congress in the last issue of The Electrical World.



Dr. Louis Duncan.

Dr. Duncan first explained why the discussion had arisen; it was found that there were no papers on the list of those to be read before the congress which touched upon the subject, and as a great many men, who had a large amount of practical experience, and who probably knew a great deal more about multiphase systems than any one in this country were present at the congress, it was desirable, if possible, to get hold of their knowledge and experience.

Dr. Duncan then briefly described the theory of the multiphase motor, and showed that the distribution of E. M. F. was such as to give a higher efficiency than is possible in direct current machines. Taking the case of two independent alternating currents with a difference of phase of 90 degrees, one is at zero when the other is at maximum, and if these are led around the magnets of a four-pole dynamo it is evident that a maximum E. M. F. is induced in each wire when it is placed in the best possible position in the field of natural strength. There is, then, a distribution of electrical force in the conductors about the armature, such that the highest electrical force is obtained exactly where it is desired. The distribution is such that the current is obtained exactly where we want it, and for that reason the conditions are better than in a continuous current machine. It has been found in the first place in working up the problem that the electrical efficiency of such a motor is a very simple expression, equal to the angular velocity of the armature divided by the angular velocity of the field. Such a motor would start up just like a continuous current motor, and would have an efficiency greater than a continuous current motor, provided there were no lagging of the current. The starting of the motors is the most serious question which has to be dealt with; if we have a motor where the drop of potential is 10 per cent. or something like that, and if the machine when starting has a current of many times the normal current, the whole distribution is disarranged. It is just as if a continuous current motor were started with the brushes shifted almost 90 degrees from the neutral point of the commutator: The question is, How is it possible to get rid of this trouble? The first thing to do would be to decrease the self-induction; this has been done by the Stanley company by placing short-circuited coils near the armature coils; but this is done at the expense of a good deal of space which could otherwise be filled with iron, and it is questionable whether it would not be just as well to utilize that space by putting more iron into it. Another way is to increase the armature resistance of the motor. There has been a great deal of trouble with multiphase motors, and one of the reasons for it is this: Suppose that a wave is applied that is not a sine curve, but is a positive and fundamental wave, a number of upper harmonics; suppose we have the E. M. F. together with the same harmonics, then the efficiency of the motor would be greatly reduced. If the motor were revolving at 900 revolutions and the field at 1,000 the electrical efficiency would be 90 per cent., but if more waves are there, say, the third or fifth harmonics, then the efficiency is greatly decreased. It is a very difficult thing to experiment on these armature currents because any ordinary means for obtaining the curve will not work. Another piece of machinery which Dr. Duncan considered of great importance, and which he hoped would be discussed, was the rotary transformer. He illustrated by diagrams upon the board the theory of operation of such a machine, and pointed out some of the inherent difficulties. He called attention to the fact that all the current does not pass through the armature, and that this is a very important point, because the question comes up as to how much energy can be transformed with one of these machines. Another question which he hoped would be discussed was that, with a given machine, say, of 100 h. p., can more energy be transformed with a three-phase than with a two-phase machine; and, if so, in what proportion. He closed his discussion by remarking that he hoped that those present who had practical experience in this line would not hesitate to speak, and that the discussion would be simple and straightforward.

Mr. C. F. Scott called attention to the Tesla polyphase system which constitutes a part of the exhibit of the Westinghouse Electric and Manufacturing Company in Electricity Building. The purpose of the exhibit is to show a complete working system for generating, transmitting and distributing power on a large commercial scale. The system includes:

I. A prime mover. II. A generating dynamo. III. Raising converters and transmission line and reducing converters. IV. Motors and rotary transformers for general power and electrical service.

The prime mover in general practice is water power, but in the present plant a 500-h. p. two-phase Tesla motor of the rotary field type serves as prime mover. The current for this motor is received from one of the 750-kw. two-phase Westinghouse generators of the lighting plant in Machinery Hall. The number of alternations is 7,200, and the pressure is reduced from 2,000 volts to 200 volts before being delivered to the motor. The current is delivered to the rotating element of the motor through brushes resting on four collecting rings. The winding is a drum winding laid in small slots in the surface. The stationary element of the motor is of laminated iron set in an outside casting. Large copper rods are run through holes in the iron plates near the inner surface, and are suitably connected at the ends. Resistances are put in circuit with this winding for starting the motor, and when speed is attained these resistances are short-circuited, leaving this winding completely closed on itself.

This motor drives a 500-h. p. two-phase alternating current generator. This machine is of the ordinary type of railway generator. There is a field of six poles which is excited by a small direct current machine driven by a 5-h. p. two-phase Tesla motor of the rotary field type. The exciter in general practice would be driven by a water-wheel. The large generator delivers from four collecting rings two currents differing in phase 90 degrees. The number of alternations is about 4,000 per minute, or 33⅓ periods per second at a potential of 360 volts on each circuit. The machine is also provided with a direct current commutator connected with the same winding, delivering current at 500 volts. This commutator would not be used when the machine is intended as an alternating current generator only. The current from this machine is delivered to a marble switchboard, where it is regulated and connected with the various transmission circuits, as desired. This board will afford facilities for connecting various circuits with any one of the several generators which may be placed in a large generating station. The current from the switchboard is received by alternating current converters or transformers by which the potential is raised in the present plant to 1,200 volts. In practice, the transformation would be to a much higher voltage, depending upon the distance of transmission. The transmission circuit conveys the current to the receiving station, where it is reduced by transformers to electromotive forces appropriate to the machines to be supplied. The current passes through a marble switchboard in which there are suitable provisions for operating the various machines in the receiving station.

The largest machine in this station is a 500-h. p. two-phase Tesla motor and rotary transformer. This machine is similar in general construction to the generator above described. The alternating current at 360 volts is passed into four collecting rings on the armature. Special connections of the field circuit are made for starting the machine, and when the motor has attained full speed a switch is turned giving the final connections and running the machine as a self-exciting synchronous motor, which maintains the exact speed of the generator by which it is driven except in cases of extreme overload. The armature of this machine is provided with a double pulley with belts driving a Worthington pump and a 40-light Westinghouse alternating current arc-light dynamo. The armature is supplied with a direct current commutator connected with the same winding which receives the alternating current, and delivers direct current at a potential of 500 volts. This current is utilized for operating two 30-h. p. street railway motors mounted upon a standard Dorner & Dutton truck, and also a 60-h. p. direct current motor mounted upon an Ingersoll-Sergeant air compressor. The direct current also supplies a series of direct current constant potential arc lamps. The current from the switchboard is also carried directly to a 60-h. p. two-phase motor and rotary transformer, which receives the current at 36 volts and delivers direct current at 50 volts adapted to electrolytic work, charging of storage batteries, and is at present used for operating the large Schuckert search light in an adjoining space. The current from the switchboard also operates a 60-h. p. two-phase Tesla motor of the synchronous type, which is adapted for any kind of constant speed work. In the present exhibit it is direct coupled to a 45-kw. slow-speed alternator of the constant potential type used for incandescent lighting. Current from the switchboard is also directly utilized for supplying incandescent lamps. Mr. Scott then called attention to the excellent mechanical design of the machines and the necessity of such work to insure success and economy in the practical operation of a plant. He described briefly the construction of the machines, and showed their fitness for the work for which they were designed. Attention was also called to the simplicity and solidity of the whole system and to its great flexibility. Mention was made of the successful installation and operation of a lighting plant for over 100 h. p. using 10,000 volts over a 28-mile circuit in southern California is an initial step which covers a distance greater than is required in a majority of the cases in which power transmission is proposed.

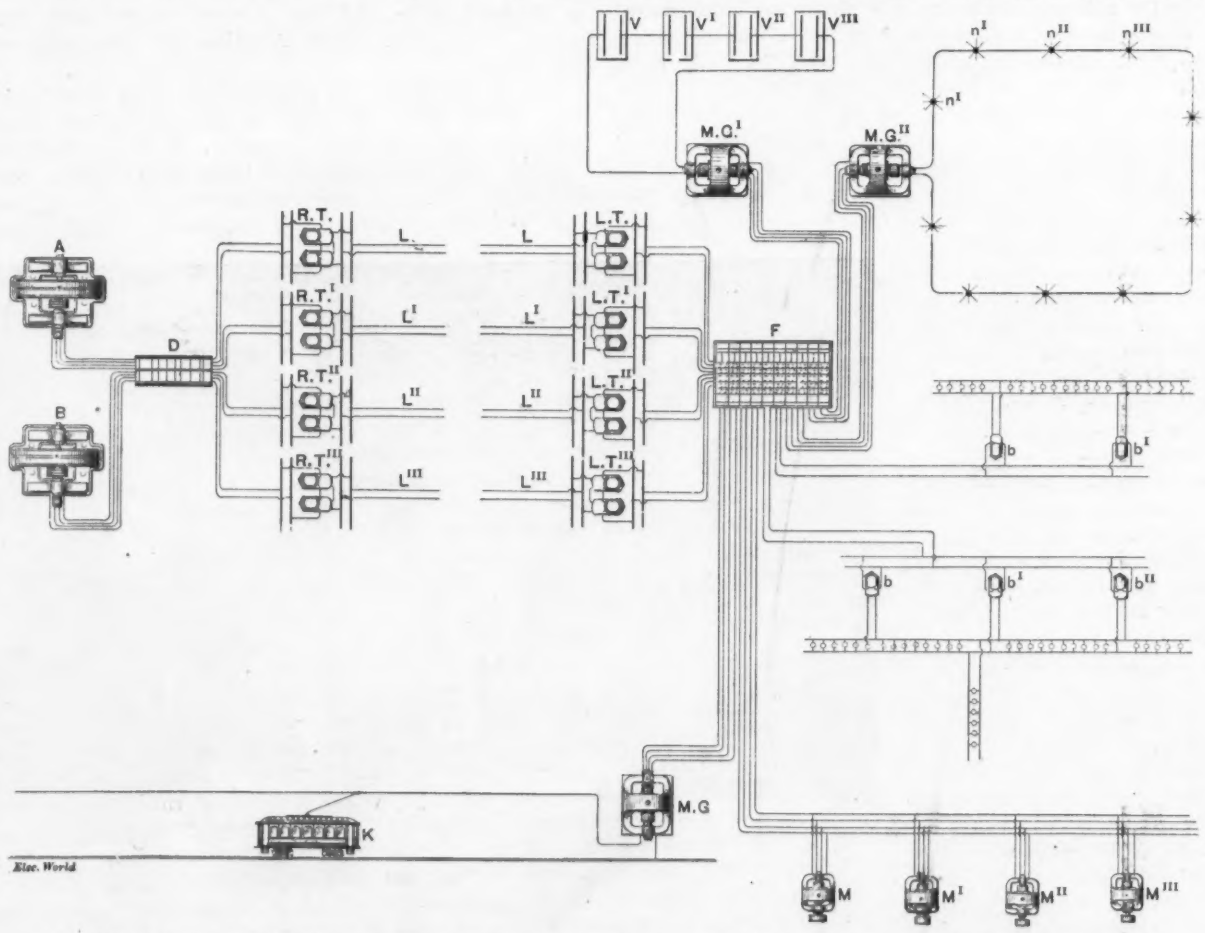


DIAGRAM OF MULTIPHASE OR TESLA SYSTEM OF TRANSMISSION AND DISTRIBUTION.

Mr. W. F. C. Hasson, of San Francisco, was then

called upon to continue the discussion. He stated that, as consulting engineer, he represented a variety of companies in California who desired to transmit power electrically to the aggregate amount of some 40,000 h. p. over distances ranging from 10 to 44 miles. Notwithstanding the fact that Mr. Scott had referred to the successful transmission of power for lighting purposes at San Antonio over 28 miles, the transmission of power electrically over long distances in California was a failure. Over a year ago the first contract for a definite transmission of power was closed, and to-day the superintendent of the mine in which the installation was made in eastern California is looking at his burned-out field coils after the generator has been in operation for less than thirteen days. The whole system just described is logical, and very beautiful on paper, but it does not establish the commercial success of long distance transmission of power. The machinery must be so built that it will not run for hours or days, but for weeks and months. Installations of this kind are almost invariably in places which are distant from railways, and where repairs are impossible, and the machinery must be of such a kind that it will be practically impossible for accidents to happen. Mr. Hasson stated that he believed in the transmission of power, and had been an apostle of it for some time in California, but that he was obliged to definitely state that as far as California was concerned the results had been failures, at least from the standpoint of the investor. Some months ago he was called upon to decide upon certain plans for the transmission of 3,000 h. p. for 20 miles; mose elaborate and beautiful descriptions of methods arriving at the results were placed before him, but not a single working drawing of any kind.

Dr. Louis Bell then took up the subject and first expressed satisfaction that a previous speaker had referred to the two-phase system as a polyphase system, because he thought that all which applies to the two-phase system applies in varying degrees to all other numbers of phases. He stated that there are in general three methods which are usually proposed for power transmission—that of the direct current, which Prof. Crocker had been championing in his paper before the Congress; that of single-phase currents and that of polyphase currents. In regard to the first, it could only be said that in this country, at least, it had not been altogether a success; the great difficulty seems to be that when the current increases to any considerable extent difficulties are at once to be met with. As for alternating currents, the reason why they are preferable is that they can be utilized in so many different ways. So long as the direct current had a monopoly of all motor service there was no choice, but at the present day that is changed; the single-phase system is now applicable to motor service, though not as well as the polyphase system, nor is it as well adapted to the operation of the rotary transformer, which is destined to play an important part in the future transmission by polyphase currents. The single-phase motor in its present state of development can be considered as nothing else than a rather poor polyphase motor; it starts on the polyphase principle, but with the objection that the rotary field established is not a circular rotary field but an elliptical one, and, consequently, gives less efficiency in the motor. Coming finally to the polyphase systems, they may be divided into two classes, those having two wires per phase or independent circuits, and those having non-independent circuits. A two-phase system with three wires is somewhat simpler than the two-phase independent circuit system; the three-phase system, operated on separate circuits, requires six wires, but with combined circuits requires only three wires—as few as are required by any polyphase system. Furthermore, in all the polyphase non-independent circuits polyphase systems save copper, as over the direct current, the simple alternating and the polyphase system with separate circuits, and this saving varies in degree from 12 or 13 per cent. in the two-phase to 25 per cent. in the three-phase. Another important feature of the three-phase dependent circuit system is that there is less self-induction and capacity on the line than in single or two-phase systems. For the installation of lights the difference between a dependent circuit system with three wires and an independent circuit system with at least four wires is very little because it is necessary to split the curcuits in any case, but in most cases three wires are more convenient than four. The great objection which has been raised against the polyphase system with dependent circuits is that it does not regulate well, but this criticism is ill founded, as we know from experiments. In the first place it is quite possible to arrange such a system so that the difference between the different branches of the circuit will be almost unnoticeable. The means of doing this are simple, and therefore it is well to state as the result of positive experiments that without any complicated means of compensation whatever it is possible to obtain closely concordant voltages in all branches of polyphase system.

In regard to polyphase motors, there is no very wide difference in principle or in operation between two, three, four, or *m* phase motors or in their action on dependent or independent circuits. When such motors are properly designed there is no doubt that they are decidedly superior to any direct current machine, and that is one of the strong reasons for using the polyphase systems.

Dr. Bell stated that he had been experimenting with motors of this type for a long time, and that he had never yet succeeded, even under the most adverse conditions, in burning out a single machine in any way whatever, a record which could hardly have been made with any kind of a direct current motor. If overloaded they will stop, and not burn out for a pretty long period; they start quite well, as well as any ordinary direct current motor; and in regard to the current required, they start just about as a shunt motor does. It is possible to run a polyphase motor at a widely varying range of speed (say, from 1-10th speed up to full speed), keeping a practically constant torque. Dr. Bell, in closing, defended the polyphase machine against the accusation of a large lagging current.

Prof. S. P. Thompson, first speaking for M. Thury, briefly described the transmission plant at Genoa, where a direct curernt of 1,200 volts was employed and no difficulties were experienced. Another interesting continuous current plant is that operating between Biberist and Rondchatel, a distance of about 20 miles. Forty amperes of current at 3,500 volts are there transmitted. At Genoa eight dynamos, all joined in series, each running at nominally about 1,000 volts, supply generators. These are all samples of practical installations for which M. Thury makes himself responsible.

In speaking for himself, Prof. Thompson first touched upon the continuous current problem, stating that many continuous current machines of high voltage had been successfully operated, and citing cases as illustrations. Coming to the question of alternating current work, he caled particular attention to the installation at Rome, where the source of power was a waterfall some fourteen miles distant. He had studied the polyphase transmission at Frankfort, where there were eight or ten different systems on exhibition, from all the great firms in the world; he did not believe that there was any best system, but that each one was best for its own purposes. He did not care to prophesy, but would give his personal opinion as to what would be the general system in use ten years from date. He did not like the complication of three-phase transformers, and three-phase switchboards and other apparatus, although he did like three-phase and two-phase alternating current dynamos and motors. The system recently described by a previous speaker was very beautiful, but he did not like its complications. In the future he thought that all the applications of polyphase work would be abandoned, and that engineers would return to simple alternating current motors; in other words, that the simple alternating current will be the one thing which ten years hence will be found to be effective for all long distance transmission.

Mr. C. P. Steinmetz remarked that out of justice he would be obliged to take the part of the continuous current; the largest amount of power distributed in the United States to-day is distributed by continuous currents; this shows that the continuous current is not dead yet, and the many references to rotary transformers showed that even the advocates of the polyphase systems still consider that they cannot get along without the old continuous current. With regard to the polyphase and single-phase systems, it makes little difference how many phases there are, because any system of polyphase currents can be transformed into any other system of polyphase currents by using two transformers only; furthermore the motors of the different polyphase systems are essentially the same. Mr. Steinmetz thought that the system of the future would be the single-phase system. There would be no longer any trouble with self-induction or capacity, for proper appliances would eliminate their effects entirely.

Prof. George Forbes stated that he was informed that there had been an organized conspiracy among the American engineers, led by no less a man than Dr. Louis Duncan, to draw out the foreign engineers on the subject of transmission of power and multiphase motors; he did not think that this referred to him, as he has ceased to look upon himself as a foreign engineer. Prof. Forbes then proceeded to outline the methods which had been adopted for the great transmission plant at Niagara Falls. The subject had been investigated most thoroughly by himself and others connected with the enterprise, in order that the best system might be selected. The first step taken was the decision that there should be central stations established at Niagara Falls to transmit power to places at greater or less distances away, as opposed to the proposition of locating all the mills directly at the Falls. It was decided that the whole of the transmission should be done by means of electricity. In 1890 a number of plans were invited from different engineers and engineering firms as to the best means of utilizing the large power of the Falls, and these plans were submitted to an engineering congress, which met in London at the beginning of 1891. Prof. Forbes in his report at that time, stated that he regarded the best means to be that of transmission by means of alternating currents of electricity; that the two-phase system should be employed with two separate circuits of high voltage; that transformers should be used for reducing the pressure down to a safe limit; that in the mills and works synchronizing alternating current motors should be used in some cases, and in others two-phase motors should be employed, and that in cases where direct current was necessary alternating motors should be used to drive continuous current machines. During the three years since that time hardly a change has been made in the system proposed.

After the congress referred to had closed, bids were asked from all the greatest firms in the world. The greatest difficulty was experienced in nearly every case by those who proposed to use continuous currents, and in every case the cost was largely in excess of that of the alternating system. Another thing which had been decided upon was to use the same system for both short and long transmission. The advantages, however, in the use of high potentials for short distances are the same as for long, and it was found that the amount of copper which would be neccessary to transmit 50,000 h. p. at a potential of 1,000 volts over even a short distance would almost completely fill a subway large enough for a man to walk through, and the cost would, of course, be prohibitive.

Prof. Forbes hardly agreed with Prof. Thompson that the multiphase motor would disappear from general use, and that single-phase motors with a multiphase means of starting would be more universally adopted; this he regarded as only one of the possibilities of the applicable to almost every class of work.

For continuous work, such as will be found in mills, the synchronous motor would be employed in the Niagara plant, but in all ordinary workshop practice where it is necessary to stop, start and reverse continually, the multiphase motor would be employed. One reason why the two-phase independent circuit transmission was chosen for the Niagara plant was that it was likely to take care of all developments which would be made for the next few years in alternating current apparatus; even if single-phase machines alone should be used the single-phase currents can be developed more cheaply by a two-phase machine than by the ordinary single-phase generator. This was appreciated as early as 1879, when Mr. Gramme built his first alternating current dynamo with two phases, having eight poles, a revolving field and a fixed armature. The water of the Niagara River, as is well known, is taken off one mile above the Falls by a large canal, which has been built; it is then taken by tunnels into the wheel pits and sent down on penstocks to the depth of 140 feet to the turbines below. These turbines have been designed by a firm of Geneva, of world-wide reputation, and have been constructed by the I. P. Morris, of Philadelphia, and will be delivered shortly. The water, after passing through the turbines, is carried down through the tunnels, which have been built to the river below the falls. On the top of the turbines is a vertical shaft coming to the surface of the ground, and rotating at 250 revolutions per minute, which enables the large dynamos to be directly connected to the shaft without gearing. Prof. Forbes then took up the question of whether step-up transformers should be used or dynamos generating a current of very high potential. He estimated that, with a loss of 3 per cent. in the transformers in the 5,000-h. p. units, $3,000 per year would be saved per unit. With stationary armatures it was as easy to build a dynamo for very high potentials, as it was a transformer itself. Overhead lines, subways or conduits were the three means by which the current could be transmitted, and it was a very serious question as to which should be used. The subway was obviously the most satisfactory, but the pole line was the cheapest. It had been decided that the work would be done either by bare overhead conductors or by bare wires carried in a subway. The transmission of power to considerable distances from Niagara Falls would confront the company in the immediate future, and it was possible that electricity would be used to propel the canal boats on the Erie Canal, in which case a line of several hundred miles in length would be required; at any rate the transmission of power to Buffalo was a possibility of the near future; the expense of a subway over such distances would be of course, very large. Experiments would be carried out with the pole system to determine its real merits. In the meantime a subway had been started which would carry conductors from the power station at least as far as the Pittsburgh Reduction Works, about half a mile distant.

Prof. H. A. Rowland did not agree with Prof. Forbes that dynamos of very high potential could be constructed without much difficulty. He was inclined to favor the use of step-up transformers. The small loss would not be of much consequence where the source of energy was a water power of such capacity. The difficulties that would be encountered in the construction of a dynamo of 10,000 to 20,000 volts would be very great. He did not know of any such in the world, and did not believe that it was practicable to build one. In the case of the transformer it was built in sections, so that there might not be more than 1,000 volts difference of potential between any adjacent wires. Then again, as the potential increases, the amount of coper which can be got into the groove in the armature becomes less and less. The matter of frequency was also

an important point, and the lower limit has never been thoroughly investigated. The first effect of reducing the frequency is to diminish the poles in the dynamo, and if we go down far enough it is necessary to slow up the machine until we have a dynamo running at a small speed, and its output is not what is desired. Again, if in a multiphase system the two sides are not perfectly balanced with a very low frequency, a tremor occurs which may produce a very great vibration of the machine, and this applies to both dynamos and motors. Further, the decrease of frequency necessitates increasing the size of the transformers in a ratio something like five to one. If it is desired to have motors running at 1,000 revolutions per minute the limit of the number of periods is somewhere about 20.

Dr. Louis Bell then considered some further points in addition to the remarks he had already made. He assured Dr. Duncan that the effects of the wave shape on the operation of single or polyphase motors was an experimental fact, but that in practice the effect on the efficiency was not likely to be great with well designed machines. In regard to the regulation of interconnected circuit polyphase systems, he had found it quite easy to satisfactorily regulate the triphase inter-dependent circuit system. It was much the same question that had arisen when the three-wire direct current system had been introduced, and the same objections were made against it. As to rotary transformers, he was not as hopeful as Prof. Forbes that any more simple form of commutator would come into general use in the near future. The rotary transformer has an efficiency from 90 to 95 or 96 per cent., and is a thoroughly reliable and comparatively simple piece of apparatus. He favored the use of step-up transformers rather than dynamos of very high potential on the ground that there was no experimental knowledge in the latter case; for extremely large machines he thought, however, that they might be built for very high voltages. In considering the line two important factors were the inductance and the frequency. As regards the inductance, the triphase or polyphase interconnected systems, for the same energy transmitted at the same voltages, give a lower induction on the line. With the triphase interconnected system the inductance is a little less than .6 of what it is on the single-phase or independent circuit multiphase system. As to frequency, the upper practical limit would probably be somewhat less than the frequency now ordinarily used, that is, 125 to 130 cycles. The lower limit would be determined in the ordinary distribution plant by the necessities of incandescent lighting; below 30 periods, or, in fact, below 33 periods, incandescent lamps do not work well. Arc lamps with the best soft cored carbons work fairly well at 45 to 50 cycles. The practical limit, then, is probably from 30 to 35 cycles. The keeping up of an overhead line is a most serious problem. The subway is, on the other hand, in most cases absolutely prohibitive from a commercial point of view. He thought that in most of the overhead work bare overhead wires must be employed, and, if they were dangerous, that people must learn to keep away from them. The limit of distance to which power could be transmitted practically depends almost entirely upon the conditions. Given the price of coal high enough power can be transmitted to almost any distance. It is absolutely necessary, however, not to economize in the matter of insulation.

Dr. Louis Duncan, in closing the discussion, stated that the tendency of most of the foreign engineers and those of the American speakers wha had had no practical experience was in the direction of the single-phase system; but that those among the Americans who had had considerable experience, and had seen the advantages of the multiphase system, were in favor of it; certainly the multiphase system at present was the only practical system for general distribution. The question of frequency was one of vast importance. If it is intended to do arc or incandescent lighting, then 50 periods per second must be used; if lower periods are used, the lag of the current is greatly increased.

Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper.

BY A. E. KENNELLY AND REGINALD A. FESSENDEN.

Abstract of a paper presented to the Electrical Congress.

In this paper, which is of the greatest value in its bearing on laboratory and other work of high precision, the authors first discuss the results obtained by Drs. Matthiessen and Siemens in their classical determinations of the temperature coefficients of copper, and find that they are discordant. The work of other physicists in the same line is also referred to, and the final results of their own determination then resumed in the statement that "they indicate a linear relation between the resistance and temperature of the wire between the limits of 20 degrees C. and 250 degrees C. represented by the equation

$$R_t = R_0 (1 + 0.00406\, t.)$$

indicating a uniform temperature coefficient of 0.406 per cent. per degree C. throughout that range, the maximum observed being 0.4097 per cent. and the minimum 0.399 per cent. at any point."

Concerning the conclusions that may be drawn, they feel only justified in saying that copper can be found in which a linear relationship holds between resistance and temperature between 20 degrees C. and 250 degrees C., and within the range of small observation errors. It is, of course, possible, they state, that in different samples of wire the temperature coefficient may increase or diminish with the temperature; in other words, the second differential coefficient of resistance with respect to temperature may perhaps in some samples be either positive or negative; it therefore seems desirable that fresh measurements should be made, and evidence collected to settle this point, and they submit the view that the best experimental means of measuring the temperature and insuring the coincidence between the measured temperature and that of the tested wire, is to inclose the latter in a bulb of an air thermometer in the manner employed in this investigation.

An account of the elaborate measurements is given in great detail in an appendix, not only to support the statements made concerning them, but also because the experimental arrangements of apparatus finally successful were the outcome of a series of experimental failures, and the details of construction may therefore be of service to those who desire to adopt the same method of measurement.

An interesting note accompanies the paper, giving the result of some measurements made on the resistance of copper wires inclosed in exhausted glass tubes and gradually raised to just visible red heat by gradually increasing the current through them. Assuming the linear temperature coefficient above determined throughout the entire range of temperature, the temperature corresponding to the lowest visible luminosity becomes 493 degrees C. (921 degrees F.). It was found that repeated tests with the same wire and the same observer will usually fall within two degrees C. by resistance valuation. There was, however, a systematic variation between the observations when the observers were exchanged, of about 3 degrees C.

DISCUSSION.

Mr. Preece stated that he would like, before the discussion was closed, to be allowed, as a representative from the other side of the water, to express not only their obligations, but their admiration for the manner in which Mr. Kennelly and his co-laborers are attacking this question. Personally he felt a very great interest in it, because it is a subject that he had himself attacked, and he only gave up the further study of the subject when he found that younger and abler men were taking it up on this side of the water.

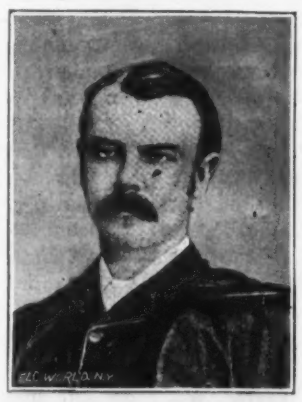
He wanted to point out to Mr. Kennelly that at Cambridge, where the question has been also carefully considered, the discrepancy between the curves of Matthiessen and Siemens, and also the discrepancy that is to be found in the text books and in papers generally as to the specific resistance of copper, is attributable to a difference of density. It has been found by reference to Matthiessen's original papers that he used copper having a density of 9. At Cambridge they had been using copper which had a density of 8.946, and it was found that with the copper at this density the difference in the specific resistance formed a direct ratio between these two numbers. The numbers, he stated, happened, curiously enough, to be among his papers, in a note that he took when Mr. Fitzpatrick read a paper on the matter at one of the meetings of the British Association, he thought it was at Edinburgh, and the figure there given was for copper at 8.946 specific gravity and 18 degrees C., 1,754; for copper at 8.9 density and the same temperature, 1,766. He remembered after that working that down with a coefficient, the coefficient then given for temperature, and he thought that if Mr. Kennelly would be kind enough to take that note and apply to it the formulas derived from his experiments with his revised coefficient that we shall find there won't be much discrepancy between the figure used in England and that used here. On the other hand, we shall all be delighted to feel that we have a coefficient derived from the unique means that Mr. Kennelly has in his possession, and Mr. Preece assured him, as a representative of English electricians, that the result of his paper will be accepted without the slightest hesitation.

Iron for Transformers.

BY PROF. J. A. EWING, F. R. S., CAMBRIDGE, ENG.

A paper presented to the Electrical Congress.

In selecting iron for use in the core of a transformer the first consideration is smallness of hysteresis losses; high permeability is comparatively a secondary desideratum. These two good qualities do not necessarily go together; the curve of the B-H cycle may have a relatively easy slope, and yet inclose a relatively small area. In actual tests the author has noticed that the order of merit in a set of samples is not always the same if permeability be made the criterion, as it is if smallness of hysteresis losses be the criterion.



Notwithstanding the obvious and well recognized importance of small hysteresis losses in transformer iron, the metal that is actually used is often of a very poor quality in this respect. The author has been much struck by this in the course of a recent experimental inquiry in which ten or dozen specimens of iron were examined, most of which were supplied either as transformer iron or as specially pure metal prepared for the purpose of the experiment. In only one case were the hysteresis losses as low as they had been found to be in some wire which the author tested in 1881, in the laboratory in the University of Tokyo, and in most cases the losses were much greater. In the Japanese tests which were made before the days of alternating current engineering, when the word hysteresis was to be found nowhere but in the Greek dictionary, wires were taken at random from the stock which the laboratory chanced to furnish. Two of them were about equally good; one of them was probably a piece of native iron, and the other was wire sent by an American manufacturer to an exhibition in Japan. Since then many observers have made tests, and, obtaining decidedly inferior results, have not unnaturally been led to express themselves in terms of politely veiled skepticism about the Japanese figures. It is, therefore, interesting to notice that one sample among those most recently tested by the author has given results which are substantially on a par with those given by the Japanese wires. Under strong magnetization it is not quite so good, but when the magnetization is moderate or weak there is practically no difference. The sample in question was thin sheet iron, used by a well known English firm in the building of their transformers. But the corporation of the old figures, interesting as it is, only serves to emphasize the contrast between the good and the bad. Other iron, also used by eminent makers of transformers, and also, like the last, carefully annealed before testing, turned out so markedly inferior that the author does not care to indicate the sources of his specimens by any more particular description. And the case was even worse with some iron supplied as specially soft and pure.

The following figures may be given as representative: They give the value of S H dI, or the hysteresis loss incurred in a complete cycle of magnetic reversal, for various values of the magnetic induction B which is reversed. Column 1 states the results of one of the old Japanese tests, column 2 refers to the good sheet iron mentioned above, and column 3 refers to another specimen of transformer metal, where, it will be seen, the losses are about half as great again as in the other. Column 4, where the losses are much greater still, relates to a test of some wire which was furnished as a specimen of particularly fine Swedish charcoal iron.

TABLE OF HYSTERESIS LOSSES.

B.	Values of S H dI.			
	1.	2.	3.	4.
2,000	400	420	600	1,100
3,000	780	800	1,150	2,150
4,000	1,2 0	1,260	1,780	3,300
5,000	1,680	1,770	2,640	4,70
6,000	2,200	2,370	3,360	6,200
7,000	2,800	3,150	4,300	7,800
8,000	3,430	3,940	5,300	9,500
9,000	4,160	4,800	6,380	11,400
10,000	4,920	5,730	7,530	13,400
11,000	5,800	6,800	8,75	15,600
12,000	6,700	8,000	10,070	.....

The figures given by Mr. C. P. Steinmetz in his paper on "The Law of Hysteresis" (Am. Inst. Elect. Engrs., 1892) give additional evidence of the wide variation which this quality is liable to exhibit in different specimens of nominally soft iron.

Chemical analysis is apparently an imperfect guide in the estimation of magnetic quality, and to some extent this is intelligible enough. Puddled iron, for instance, liberally streaked with slag, may seem on analysis less pure than specimens of ingot metal which have much higher hysteresis losses. It is not improbable that much of the inferiority which most modern sheet and wire iron undoubtedly shows in this respect may be due to traces of foreign elements which have become chemically incorporated with the metal through the use of methods of manufacture which are ill adapted to yield a good product from the magnetic point of view, however successful they are in producing a mechanically good iron. Manganese, so essential to the strength and toughness of ingot iron, is well known to be deleterious magnetically. The makers of transformers complain that they are unable to get metal of the quality they want except by a kind of happy accident; that the conditions which bring about a good result are so imperfectly understood that they cannot be reproduced with any certainty. Much the same thing was true in the early days of mild steel, and incessant testing contributed to put matters on a surer footing. Magnetic testing is now easy for makers as well as users of iron, and it may be expected that specifications of magnetic quality, and particularly of hysteresis losses, will soon become commoner than they are. From being a mere laboratory affair, interesting only to the curious physicist, the subject has in a few years advanced to the front rank of practical questions, and affects wide commercial interests.

The form and general design of transformers has received all possible attention at the hands of engineers, but of the material which mainly determines their efficiency we apparently know very little. It is scarcely satisfactory to reflect that good makers are turning out machines which waste twice as much power as they need waste.

The author brings these remarks before the congress in the hope that some suggestions may be made which will lead to a better understanding, as between electricians and iron makers, of the conditions which govern the production of magnetically soft iron.

Electrical Engineering Symbols.

BY PROF. A. JAMIESON, M. INST. C. E., ETC.

A paper presented to the Electrical Congress.

Note.—In the following list of symbols the system has been to use the *first* letter of the chief noun or most important word. Where necessary, the first letter or letters of the adjectival substantive or qualifying words have been added as a subscript letter or letters. All specific quantities and coefficients are distinguished by small Greek letters. Further, owing to use and wont, δ, ε and ω have been retained as in the list.

These symbols have been submitted to a number of the leading electricians of Great Britain, and have met with general approval and acceptance.

FUNDAMENTAL AND DERIVED MECHANICAL UNITS.

L	for length.
M	" mass.
T or t	" time.
V	" volume.
v	" velocity.
a	" acceleration.
g	" " due to gravity.
F or f	" force.
δ	" dyne; *e. g.*, 10 δ for 10 dynes.
ε	" ergs; *e. g.*, 10 ε for 10 ergs.
W	" work.
ft. lb.	" foot-pound.
H. P.	" horse-power.
I.H.P. / B.H.P. / E.H.P.	" indicated, brake, and electrical horse-power.

SYMBOLS IN GENERAL USE.

D or d	for diameter, r for radius.
π	" circumference ÷ diameter.
τ_1, τ_2, τ_3, etc.	" temperatures, small differences.
$t_1^\circ, t_2^\circ, t_3^\circ$, etc.	" " common.

θ or d_1, d_2, etc. for angle of deflection or deflections of galvanometer needle.
n " number of anything.
G " galvanometer; s for shunt.
" battery or cells (the long stroke | for + and the thick stroke | for — pole).
" dynamo (continuous current).
" motor (continuous current).
" dynamo (alternating current).
" motor (alternating current).
" transformer (continuous current).
" transformer (alternating current).
~ " frequency, periodicity, or cycles per second.
" inductive resistance.
" non-inductive resistance.
T_{aw} " turns of armature wire.
T_{mw} " turns of field-magnet wire.
N_{ar} " number of armature revolutions.
E.M., F.M. " electromagnet; field magnet.
for arc lamp; —○— for glow lamp.
c.p. for candle-power of a lamp.
A.M., V.M. " ammeter; voltmeter.
P.D. " potential difference.
G.P. " gutta percha.
⊣⊢ or —⊏⊐— " condenser.
S.W.G. " standard wire gauge (legal).

PRACTICAL ELECTRIC UNITS.

R and r_1, r_2, etc., for resistance, any resistance.
R_1 " resistance, insulation.
ρ " resistance, specific.
ω " ohm; *e g.*, 10 ω for 10 ohms.
Ω " megohm; *e.g.*, 10 Ω for 10 megohms.
C and c_1, c_2, etc. " current, any current.
A " ampere; e. g., 10 A for 10 amperes.
E and e_1, e_2, etc. " electromotive force, any E.M.F. or *e.m.f.*
V " volt: *e. g.*, 10 v for 10 volts.
K and k_1, k_2, etc. " capacity, any capacity.
κ " specific inductive capacity.
Mfd or *m.f.d.* " microfarad; *e. g.*, 10 *mfd* for 10 microfarads.
Q and q_1, q_2, etc. " quantity or coulombs.
B.T.U. " British thermal unit.
B. T. or b.o.t. " Board of Trade unit.
P_W " power in watts, or watts.
W_J " work in joules.
J " Joule's equivalent.
z " electro-chemical equivalent (grammes per coulomb).
R_a, R_m, R_s, R_e " resistance of armature, main, and shunt coils, and external circuits respectively of a dynamo or motor.
C_a, C_m, C_s, C_e " current in armature, main, and shunt coils, and external circuits respectively of a dynamo or motor.
E_a, E_b, E_s, E_e " E.M.F. in armature and P.D. at brushes, shunt, and external circuit of a dynamo.
I or i " all alternating currents to be denoted by I or i (I, maximum; i, effective).—*Paris Congress.*
L_s " coeff. of self induction or inductance.
L_m " coeff. of mutual induction.
I_m " impedance or virtual resistance.

MAGNETISM AND MAGNETIC UNITS.

Magnetic quantities are signified by block letters in certain cases, to distinguish them from the electrical and other symbols.

N for north pointing pole of a magnet, generally painted red.
S " south pointing pole of a magnet, generally painted blue.
m " magnetic strength of pole.
" distance between the poles.
ml " moment of a magnet.
H " horizontal intensity of earth's magnetism.
I " intensity of magnetization.
H " strength of field.
B " induction per square centimetre $= 4\pi \mathbf{I} + \mathbf{H}$.
μ " magnetic permeability or coefficient of magnetic induction.
$$\mu = \frac{\mathbf{B}}{\mathbf{H}}.$$
κ " magnetic susceptibility or coefficient of induced magnetization
$$\kappa = \frac{\mathbf{I}}{\mathbf{H}}.$$
$\mathbf{L}_m$, $\mathbf{L}_{as}$, $\mathbf{L}_a$ " length of magnetic circuit in dynamo magnets, air spaces, and armature respectively.
$\mathbf{S}_m$, $\mathbf{S}_{as}$, $\mathbf{S}_a$ " section of dynamo magnets, air space, and armature respectively.
R " magnetic resistance or reluctance of any magnetic circuit $= \frac{\mathbf{L}}{\mathbf{S}\mu}$
$\mathbf{R}_m$, $\mathbf{R}_{as}$, $\mathbf{R}_a$ " magnetic resistance or reluctance of cores and yoke, *air space*, and *armature* core respectively of a dynamo or motor.
E " exciting or magneto-motive force = 1.257 ampère-turns in a solenoid
$A \times T_{mw}$ " ampère turns of magnet wire.
M " magnetic flux or flow or total number of lines between poles or two parts.

Underground Wires for Electric Lighting and Power Distribution.

BY PROF. D. C. JACKSON.

Abstract of a paper read before the Electrical Congress.

After referring to the advantages of placing wires under ground, Prof. Jackson points out that there are two systems in use in the United States for this purpose: First, solid, or built in systems; and, second, drawing in, or conduit systems. While the first cost is slightly greater for the conduit systems, it has very many advantages in its favor, and the Edison is the only important example of the first system used in this country. Of the two classes of conduit systems that have been used—insulating and non-insulating—the former has generally gone out of use on account of its defects, as it has been found absolutely impossible to maintain the insulation on account of the condensation of moisture. Of the second class there are four typical forms—cast, or wrought iron pipes; cement lined sheet iron pipes; tile, terra cotta, or clay pipes, and wood tubes. The most generally used are made of glazed terra cotta, with one or more rectangular ducts, each one capable of carrying at least three cables. Rectangular ducts have considerable advantage over round ones, and it would be an advantage if the glaze of the ducts did not have a high electrical resistance, in order to prevent shocks to linemen from static effects or leakage. There is a great diversity of opinion as to the proper depth to which a conduit should be laid. If it be possible the depth of the top of the conduit should be about two feet below the pavement when it is laid in concrete. If clay pipe is laid bare in the earth they should generally be about three feet deep. The tiled conduit should be laid in a bed of from two inches to six inches of concrete, and covered with concrete to that depth so that when the hole is hardened there will be a continuous set of stone ducts. The top may be further protected by creosoted board if the conditions make it necessary. Joints between the sections are made, either by wrapping the joint with several layers of burlap strips, soaked in hot asphalt, or by means of a tile sleeve over the joint, which is cemented on. The latter joint is usually used when the conduit is laid in concrete, and in laying the conduits is then usually sufficient to simply bring the sections together in a line in a trench and fill in with concrete.

House services are sometimes taken off from these ducts by means of hand holes in front of each house, and sometimes the service wires are taken from the manholes and carried into each block by a subsidiary duct, whence they are distributed overhead over the roofs, or otherwise. The all underground method is the best, but is more expensive and less frequently used. The experience of those who have used the tiled ducts seems to be favorable, and is well spoken of in a number of large cities where it is used.

In Milwaukee an ordinary sewer pipe has been laid in the same manner as tile with cemented joints but no concrete, which makes it a little cheaper than the special forms, but the system has not been long enough in use to pronounce on its merits.

The simplest of all conduits, and one used quite generally, is common gas or steam pipe, either laid bare in the ground or in a bed of concrete; the great advantage is its flexibility. Some authorities claim that a conduit should never bend, but experience has proved that cables can be easily pulled around curves with radii of three feet or less. A disadvantage of iron conduits is from its magnetic qualities increasing the impedance of alternating currents carried through them. Mr. Preece found a fall of pressure of two volts with a current of 7.2 amperes and a resistance of .0088 ohm where conductors were thus arranged. A satisfactory commercial remedy for this is to use duplex conductors or place the two wires of the circuit close together. The greatest cause of deterioration in iron conduits is oxidation.

The Johnstone conduit is sometimes used for distributing from wrought iron pipe. It consists of cast iron sections five feet long containing two rows of square ducts. This conduit is laid bare in the earth, and the joints made fairly tight with plumbers' putty; before every alternate house there is a removable top, and a place in the side of the conduit where a subsidiary pipe may be screwed in makes it possible to take off services without expensive handholes or manholes. This conduit is laid quite near the street surface, and being of cast iron lasts better, but lacks flexibility and is heavy.

Wooden conduits are used extensively in Philadelphia, Chicago and Brooklyn. The thickness of the wall is about 1¼ inches, the top being easily covered by a two-inch plank for extra mechanical protection. The commonest form is made up of 4 by 4 pieces of wood with a 3-inch hole bored through from end to end and jointed together either by a male and female union or by simply butting the ends. Preservatives, oil of coal tar, carbolineum and other compounds have been used.

One of the greatest advantages claimed for the wood conduit is its accessibility, as the wood may be cut away at any point to make a connection; but generally the distribution is made from the drawing in manholes. The greatest disadvantage is the chemical effect of the preserving compound on the lead covering of the cables. The durability of the treated wood conduit may be thirty years and probably much longer, while untreated wood will not last more than fifteen years.

The only other type of conduit which is being used on a large scale is the cement lined iron pipe. It is claimed that the pipes used for this purpose are water and gas tight, and proof against acids and akalies; this pipe is one of the best to draw cables into that has been tried.

It is probable that the effect of wood conduits on the cable and the lack of flexibility balance the arguments in their favor (such as durability, continuity and accessibility), except for temporary work. The arguments in favor of cement lined pipe are smoothness and cheapness, and it doubtless makes a very satisfactory conduit where the special arguments in favor of iron pipes do not apply. For use where there is room for a good sized conduit without many bends or where the amount of tearing up the streets is not excessive the vitrified clay conduit seems to be best, as its smooth ducts are easy to draw cables into; where, however, the streets are filled with a mass of pipes of all kinds, and a conduit may be broken into by workmen at any time, the flexibility and strength of the iron pipe are necessary, notwithstanding its greater first cost and probable greater rate of deterioration.

Prof. Jackson describes different systems of manholes in detail, and concludes that the comparative cost of different conduit systems is difficult to estimate, as it depends upon so many local conditions. It may be divided into cost of excavation and refilling, and the cost of material and laying the conduits. The first part will vary greatly with the kind of paving, depth of conduit, etc., but is nearly independent of the kind of duct used. The rate of depreciation of subway has not yet been determined, but from the use of similar materials for other purposes, it may be estimated as being four per cent. or less for iron pipe, and less than that for any of the other kinds if they are properly protected from mechanical injury. The cost of maintenance should be almost nothing, but actual figures for the conduit alone cannot be obtained.

The New Incandescent Arc.

BY L. B. MARKS.

A paper read before the Electrical Congress.

The incandescent arc to be treated of in this paper differs radically from any of the typical forms in which two electrodes are in imperfect contact. In it the electrodes are not in contact, while the current is indirectly used in maintaining all the products of disintegration of the carbon in a state of incandescence or opalescence.

The accompanying illustration shows its main features. It will be seen that the arc is inclosed in a small envelope, which is made of highly refractory glass. The envelope is closed at the bottom and provided on top with a metal plug having an opening in it just large enough to admit of the feed of the upper electrode. A fireproof plug of asbestos pulp insulates the metal from the glass. A valve shown in the plate allows the egress of gas, but prevents ingress of the air. With this construction the operation of the lamp will be as follows:

Upon the closure of the circuit and the springing of the arc, the air in the inclosing envelope is robbed of its oxygen, the latter uniting with the carbon of the electrodes to form C O and C O_2 gases.

The gases are brought to an exceedingly high temperature at which they maintain the carbon vapor issuing from the arc. This vapor is deposited in the form of a thin coating on the internal surface of the glass chamber.

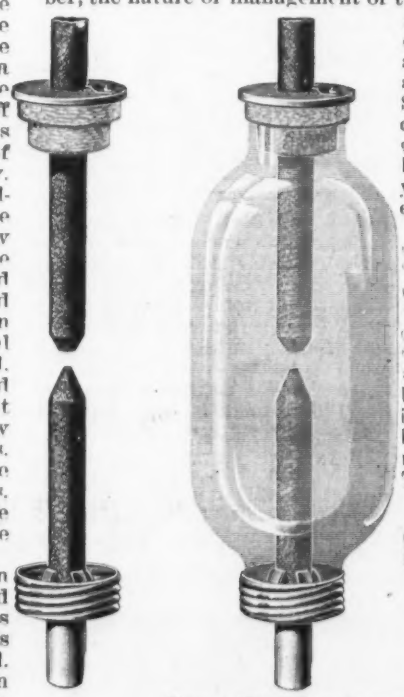
The expansive force of the gases may become sufficiently great, if no means of egress be provided, to rupture the envelope; hence, a small safety valve is provided for their outflow. The only possibility of ingress of air is through the narrow space between the positive carbon and the plug; experience has shown that after the temperature has been raised beyond a certain point the amount of air that enters in this way is inappreciable; in any event the oxygen is immediately converted by combination.

It is important that the inclosing glass envelope be as small as possible, for the conservation of the radiant energy, and hence the efficiency will depend largely upon the size of the chamber. The heat which, in the ordinary arc light, is dissipated in the air, is here conserved and raises the temperature of the inclosed gases and vapor of carbon. The proper conditions being fulfilled the lamp maintains its maximum efficiency shortly after the current has been passed through it, and glows like the incandescent with the brilliancy of the arc light. The arc proper is scarcely visible, but the entire contents of the chamber seem to be luminous, giving the appearance of a solid cylinder of light.

The pressure as well as the temperature of the inclosed gases has a very important bearing on the performance of the lamp, and affects to a marked degree the character of the carbon deposit on the glass chamber. At this date no definite figures can be given, but it appears that a high tension is absolutely required to give good results.

The structure and constituency of the electrode are also pre-eminently important. Absolute purity of the carbon is imperative.

Investigators in this field have apparently found it impossible to obtain all the requisite conditions. Beardslee mentions a type of lamp similar to the one under discussion, but whether the size or character of the arc closing chamber, the nature or management of the gases, or the quality of the electrodes, or other features made his arrangement impracticable, is not recorded. Suffice it to say, the comparatively poor grade of arc light carbon manufactured ten years ago would alone explain his failure.



THE "NEW INCANDESCENT" ARC.

It is interesting to note here that attempts have been made at various times to save carbons in arcs by excluding the oxygen of the air. Baxter devised several forms of arc lamp with this object in view. The subject has been more recently referred to by Thomson. These experiments were attended with little practical success, not because the desired ends were infeasible, but probably because, as in the case of Beardslee's apparatus, alluded to above, one or more of the requisite conditions had not been attained. It appears that the saving in life was more than counterbalanced by the loss in light. The "incandescent effect" was absent, and the unsteadiness of the arc itself was fatal. The results were almost identical with those obtained when the arc is formed *in vacuo*. In this case there is a tendency of the carbon to deposit as a soot on the sides of the vacuum chamber, an effect consequent upon the vaporized carbon in the arc being carried off and condensed again as soon as the vapor escapes the heat of the arc stream.

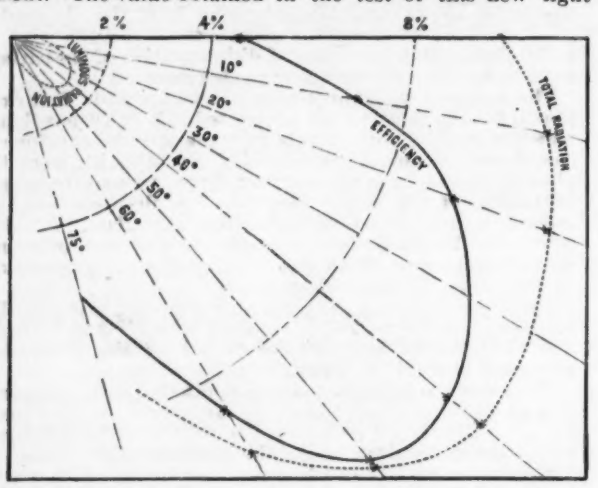
But the requisite conditions hereinbefore named being

once attained, the arc is really a beautiful phenomenon. It differs in many respects from the arc in open air, being especially steadier than the latter. The light, emanating from the incandescent vapor of carbon, appears to issue from all parts of the small inclosing envelope, the area of the source of illumination being limited only by the size of the chamber.

Efficiency Measurements.—Measurements of the efficiency and candle power of the light were made in the laboratory of Cornell University. The method employed in making the efficiency tests was that used by Nakano in determining the efficiency of the arc lamp, and subsequently by the writer in an investigation on arc light carbons. The ratio of luminous to total radiation of the lamp was taken at different angles below and above the horizontal.

Fig. 1 represents the curves platted from these values obtained, the dotted line curves showing the distribution of luminous and total radiation respectively, and the full line curve the measure of the efficiency below the horizontal.

The value of the mean hemispherical efficiency is obtained by integrating the curve, and is found to be 8.4 per cent. The mean efficiency of the ordinary arc is about 10 per cent. The mean efficiency of the incandescent lamp, according to Merritt, is rather below than above 5 per cent. The value obtained in the test of this new light



Mean current = 9 amp. Mean P. D. = 55 volts.

Fig. 1.

therefore lies between those of the two present forms of electrical illumination, approaching, however, more nearly that of the arc.

While it is true that the average efficiency of the electric arc in open air nets about 10 per cent., it is questionable whether in commercial practice in this country this value is often reached. The writer has made tests of a standard brand of arc light carbon where the efficiency was only 7½ per cent.

Glancing at Fig. 1, we note that while the form of the efficiency curve differs entirely from that of the incandescent lamp, it is not unlike that of the arc. The distribution of light giving energy is, however, more uniform than in the arc, a fact which is more prominently brought out in comparing the candle power curves of the two. While the approximate law, hemispherical efficiency = ¼ horizontal, + ¾ maximum, holds for the ordinary arc, the mean of several tests indicates that—

Hemispherical efficiency = ¼ horizontal + ¾ maximum fairly represents the conditions manifested by the incandescent arc, curves Figs. 1 and 2.

Tests were made to determine the effect of initially coating the internal surface of the cylinder with various ingredients other than carbon. No marked difference in the efficiency was discovered. Fig. 2 represents a curve taken in this way. The mean hemispherical efficiency was 8.02 per cent.

Candle Power Measurements.—Fig 3 is platted from the candle power measurements from which the curve, Fig. 3, was platted. Distances measured along the radii give the candle powers for the various angles throughout the "zone of useful illumination."

CANDLE-POWER MEASUREMENTS.

Mean current = 8 ampères. Mean P. D. = 63 volts.

Angle.	0°	−10°	−20°	−30°	−40°	−50°	−60°	+20°
Candle power	218	283	455	590	595	515	450	170

Distribution of Light.—It will be seen that the distribution of light as shown by the candle power curve differs considerably from that of the ordinary arc. Especially is this true at angles greater than 50 degrees below the horizontal. The turn in the curve is not so sharp as in the arc, and there is much less difference between the maximum and the mean amount of light; in fact, to the naked eye the intensity of luminous radiation does not seem to vary much from 20 degrees to 60 degrees below the horizontal, while in the arc the change is very marked between these limits. Thus the formula of Gerard, namely:

Hemispherical c. p. = ¼ horizontal c. p. + ¾ maximum c. p. which may be used to advantage in arc light approximations, will not hold in this case; but the form of the curve, as well as the nature of efficiency curves above referred to, suggests the substitute.

Hemispherical c. p. = ½ horizontal c. p. + ½ maximum c. p.

The mean or hemispherical candle power below the horizontal, obtained by integration of curve Fig. 3, equals 431, thus allowing 1.17 watts per candle, or 637.6 candles per electrical horse power—nearly three times the average illumination of the incandescent lamp using the same energy.

The results of tests show that the mean hemispherical candle power of the ordinary arc measured as in the above case averages about 600; the mean watts per candle .84, or 888 candles per electrical horse power.

Comparing these measurements with those of radiant efficiency, it appears that the ratio,

$$\left\{\frac{\text{Hemispherical c. p., "incandescent arc."}}{\text{Hemispherical c. p., ordinary arc}}\right\}$$

is considerly smaller than the ratio,

$$\left\{\frac{\text{Hemispherical efficiency, "incandescent arc"}}{\text{Hemispherical efficiency, ordinary arc}}\right\}.$$

The explanation of this difference undoubtedly lies in the quality of luminosity of the light omitted by the incandescent arc. Nichols has pointed out that the relative efficiency, as determined by the ratio $\left\{\frac{\text{luminous radiation,}}{\text{total radiation,}}\right\}$ "does not coincide with that obtained from the ratio of watts to candle power, for the reason that the various rays which make up the visible spectrum do not enter into the production of candle power in proportion to their energy." Luminosity is a potent factor in determining the real efficiency of any source of illumination. Lack of time has prevented the investigation of this important phenomenon, but at its maximum efficiency the light from this form of incandescent arc, though not so intense, unmistakably appears brighter than that of an ordinary arc of equal candle power as interpreted by the photometer.

Life Tests.—Oxygen being practically excluded from the arc inclosing chamber, prolongation in the life of the electrodes is an implied concomitant.

In the ordinary arc "while the positive carbon loses by volatilization from its tip or crater, and by combustion from its sides, the negative gains no deposit, but wastes at a less rate than the other, and by combustion only."

Hence, if the exclusion of oxygen were complete we might expect an indestructible negative. This condition, however, has not been fulfilled in any of the tests made thus far, but the results fully substantiate the theory. Absence of combustion on the one hand and the tension of the inclosed gases on the other combine to greatly reduce the amount of disintegration of the positive electrode.

The following table gives the results of life test with a pair of pure carbons ½ inch diameter, and specially constructed for the purpose.

The lamp was placed in the circuit of a constant current dynamo, running about eight hours per day; readings were taken at given intervals and the total length of run was limited to 100 hours.

LIFE TESTS—ONE-HALF INCH CARBONS.

Mean currents, 9 5/16 amperes. Mean P. D., 55 volts.

Initial length (+) carbon (inches).	Initial length (−) carbon (inches).	Duration of run (hours).	Loss in length (+) carbon (inches).	Loss in length (−) carbon (inches.)	Life per inch (+) carbon (hours).	Life per inch (−) carbon (hours).
10.31	4.63	100	6.81	0.69	14.67	145.45

Thus making 1.69 inches per hour as the average consumption of carbon in the commercial 350 watt lamp, run at 5½ amperes and 50 volts; we note that although 525 watts, or one and one-half times the energy, have been expended in the case of the lamp under consideration, yet the life per inch of carbon consumed is more than twenty times that of the other. Indeed the figures show that the life of the negative was nearly one hundred times as great as that obtained in commercial practice to-day.

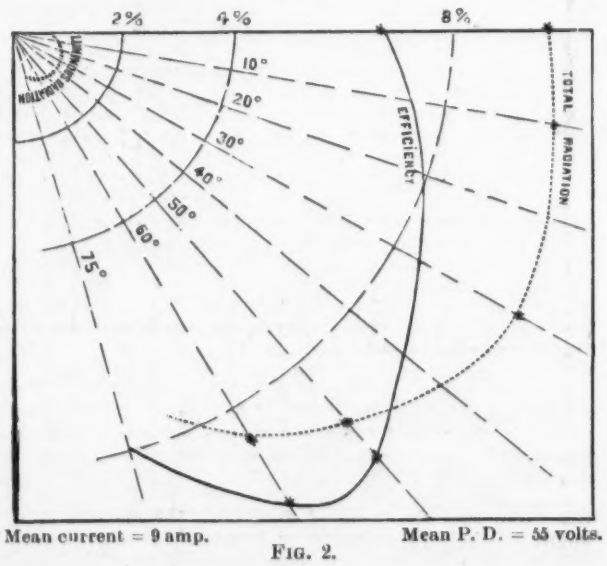
The preservation of the negative is a very interesting feature of this type of lamp. There is a marked tendency towards deposition of the products of volatilization of the upper electrode, on the tip of the lower, the carbon deposited, if not ruptured by the action of the lamp, forming an integral part of the negative.

In one case where, the arc having been sprung, the electrodes did not come in contact during the entire run, this "building up" process was beautifully exhibited, the negative electrode gaining practically all that the positive lost. The current in this instance was 10½ ampères, and the P. D. 50 volts. The duration of the run was eleven hours.

Observation of the Arc.—Relation of P. D. to Length of Arc and Quality of Carbon.—The effect of the inclosed gases on the form and character of the arc presents a large field for investigation.

On account of lack of sufficient data no attempt will now be made to state much of a definite nature regarding this subject; but it is hoped that the matter will be given due attention in the near future.

The difference in potential between the electrodes being equal, the incandescent arc is longer for a given current than the ordinary arc; under some conditions it has been found to be almost twice as long. If we accept the conclusion of S. P. Thompson, that "the arc is independent of the nature of the surrounding gas," we must then look to the effects of the tension or pressure of the heated gases upon the arc to explain this difference in length. It has been found that there is a constant increase of P. D. with pressure above atmosphere for a given current and length



Mean current = 9 amp. Mean P. D. = 55 volts.

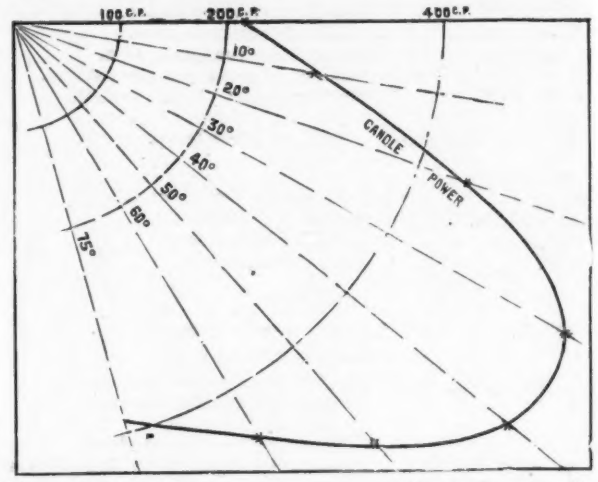
Fig. 2.

of arc. But in spite of this fact, the decrease in resistance of the arc under the conditions named appears to allow of a greater length for the same P. D.

Flaming and Hissing.—In the ordinary arc the carbon vapor carried off from the positive is consumed by the oxygen of the air before it can deposit on the negative. Hence the ever present "zone of flame" as distinguished from the arc flux proper is really a zone of combustion. In the incandescent arc, however, there is naturally no zone of flame, consequently the phenomenon of flaming common to the ordinary arc does not occur. The arc tends to centre itself, being propably aided in so doing by the pressure of the surrounding gases; moreover, the slow consumption of the electrodes lessens the tendency to wander. With cored carbons there is a perceptible crater, but with solid pencils the tips become more or less flattened.

The quality of the carbon has an important bearing on the P. D. between the electrodes. Generally speaking, it has been observed that with soft, fine-grained carbons the P. D. is considerably lower for a given current than with harder or coarse grained pencils. The tendency to hiss, however, is not so marked when the electrodes are consumed in the gas chamber as in the open air; in the former case the disintegration is so slow that the "electrolytic" vaporization, as it has been called, does not appear to explode the particles. It is interesting to note here that these results confirm a theory of hissing advanced by Prof. Thomson a few years ago.

The Alternating Current "Incandescent Arc."—No measurements were made using the alternating current; but the appurtenance was applied to the alternating current arc lamp to determine the effect on the noise of the arc. The hum was in a large measure reduced, but whether the reduction was due mainly to the mere fact of the arc being inclosed in an air-tight compartment or not is questionable. But, as the hum became much slighter after the lamp had been in operation several minutes, the action of the heated gases being then manifest, it is plausi-



Mean current = 8 amp. Mean P. D. = 63 volts.

Fig. 3.

ble that the diminution in the noise was not due entirely to the shielding property of the glass envelope.

While it has been proved that the "humming of the alternating current arc is due to the rapid periodic extinction and re-establishment of the discharge," the singing tone may be greatly modified, if not entirely overcome, by the substitution of any incandescent arc of the Reynier type. A few years ago the writer had occasion to test an alternating current arc lamp trimmed with carbons which had been provided with a core of pulverized mica and carbon. The springing of the arc was accompanied by the usual hum, but as soon as the mica fused the noise ceased. The conditions were similar to those of an incandescent arc, the plastic mica-carbon core constituting a high-resistance medium between the plus and minus electrodes. There was really no true arc. The amount of light was naturally greatly reduced. In the case of the incandescent arc first alluded to, there seems to be an approach to these conditions, the arc stream acted upon by the gases inclosed in the chamber appearing to have a greater density, if we may call it that, than under normal circumstances. The amount of light in this experiment was, however, apparently as great as in the direct current tests.

Prof. Nichols, of Cornell University, in opening the discussion, stated that this paper seemed to indicate two or three essential advantages in electric lighting. The expense of replacing carbons and the diffusion of the light are two important features. The diffusion is apparently obtained without loss of efficiency. Pure carbons must be used, but this is not a serious objection.

Prof. S. P. Thompson stated that he had made considerable investigation in this line, especially upon the behavior of the arc in various kinds of atmospheres. He was not sure that there was any great commercial gain in making carbons burn slowly if it necessitated expensive carbons, a more or less complicated envelope, etc. Mr. Thompson then described the method and apparatus used by him in proving that the energy is almost all spent at the crater surface on the positive carbon.

Mr. Geo. P. Low called attention to an incandescent lamp shown to him in San Francisco, operated under a potential of between six and eight volts, in which the carbon was brought at 24 amperes to a plastic mass that was drawn out between 3-16 and ¼ of an inch.

Prof. E. P. Roberts inquired what the experience had been with the valve in this lamp, and whether there was not danger of explosion, to which Mr. Marks replied that he had found some trouble in this direction at first, but it was soon remedied. The valve had been perfected and a very superior quality of glass was used.

Mr. Geo. W. McDonald stated that his experience led him to believe that this was an impracticable solution of a lamp in which the carbons could be preserved or made to burn a longer time than is now the case. Carbon material is thrown off by the arc in such quantities as to cover the glass inclosure and impede the exit of the light rays. To this objection Mr. Marks replied that the trouble was due to the quality of the carbons, which must be absolutely pure; that the coating of the glass was a practical benefit, as it gave a more symmetrical distribution of light.

On Direct Current Dynamos of Very High Potential.

BY PROF. F. B. CROCKER.

Abstract of a paper read before the Electrical Congress.

After referring to the general opinion in regard to the practical limitation of continuous current dynamos to a voltage of 5,000 and a current of 10 amperes, Prof. Crocker proceeds to consider the various points necessary to be observed in constructing machines in which these limits may be exceeded. The first point, of course, is insulation. That must be above suspicion. The ordinary limit of one megohm of insulation is simply nothing for such machines. One megohm of insulation resistance, with a voltage of 10,000, will give 1-100 of an ampere and 100 watts; consequently the machine insulation would be rapidly heated up and destroyed; therefore, you must realize that a megohm, or even several megohms, is no insulation at all for such a machine. It should be at least 1,000 megohms, which is number one, in fact. The next point is the commutator, because, although the commutator might be considered the first point, as a matter of fact, we must have the insulation before we can operate the machine at all, even for a few moments. The commutator, of course, must have a number of sections. It must have a considerable thickness of mica insulation between the bars, more than is ordinarily employed; say a full 1-16 of an inch. On the end of the commutator, where we get much more than the ordinary voltage between the bars, we require very much more thickness of insulation, because there is between points there the total difference of tension which exists, and it is only necessary for the current to jump two points in order to produce a short circuit. That is not the case, of course, between adjacent commutator bars. At that point there should be an actual thickness of insulation of a quarter of an inch, and if possible the surface distance should be increased by having the insulation project.

The next point, said Prof. Crocker, is the material for the brushes. In the first place, it is impossible to run an ordinary mica insulated commutator with copper brushes at very high potentials, the reason being that the film of copper which is worn off the copper brushes by the mica is a sufficiently good conductor at that electromotive force to carry many watts of current. At an electromotive force of, say, 500 volts, there is no such difficulty, because even if common brush connections are used the film of copper that is rubbed on to the surface of the mica would not carry sufficient watts to cause any trouble; but at 10,000 volts, with a total electromotive force in the neighborhood of 100 volts between the bars, the amount of copper, even although it is an almost infinitesimal film, is sufficient to carry many watts of current.

Prof. Crocker has found that with a potential of only 5,000 volts copper brushes could not be used for half a minute; that the copper was worked off and immediately produced a ring of fire all around the commutator. Naturally one would use carbon brushes in such a case, because the current is very small, comparatively speaking, and there is no reason why we should not use carbon brushes, for, to simply state the fact decidedly, you cannot use copper brushes for the reason given. When you come to the carbon brushes, it has also been found that the hardened carbon is better, for the reason that it does not produce a deposit or layer of carbon on the commutator to produce the same effect which the copper does, but not to the same degree, because carbon is a much poorer conductor than copper; therefore carbon brushes, with a comparatively small area of contact and a fairly good pressure, not very great, but sufficient to insure good contact, seem to be the proper working conditions.

Prof. Crocker then describes two machines that he has built. One was a small machine of one h. p., with a fluted armature, which type of armature he considers best for the purpose, and was very perfectly insulated with mica and wound with double silk covered wire. There were only 32 commutator bars with, say, 350 volts to the bar. That machine was not, of course, a practical machine, but it ran for hours at 5,000 volts; for an hour and a half at 5,500 volts. That simply shows the minimum number of commutator bars that can be used. The current possible to get from that machine, of course, is small. As soon as a current is drawn from a machine of that small number of commutator bars there is a tendency to stop the working, and that, of course, produces a ring of fire.

The next machine, which is a much more practical machine, was of 5-h. p. capacity, and designed to generate 10,000 volts. It did generate 10,000 volts at a little below the calculated speed, strange to say, and gave 11,000 volts at about the speed it was designed for, which was 1,800, not a high speed. This machine had 108 commutator bars, a much more practical number for such a voltage. The current of the machine was intended to be between three and four-tenths ampere, which gives about its capacity. It must be remembered that these machines did not give their full capacity, owing to the fact that the wire is extremely small, and, therefore, the percentage of copper in the winding is small. The winding is largely made up of silk, consequently the capacity of the machine is reduced by that fact. The current actually obtained from these machines is in the neighborhood of their rated capacity.

It would be unfair to deny the fact that there is a spark when the current capacity of the machine is approached, and at the current capacity the sparking would probably be too great. This machine has something like 1,500 ohms internal resistance, which is a perfectly normal voltage. The voltage is so high and the current is so small that an armature resistance of 1,500 ohms is perfectly proper. Of course, the proper, or allowable, armature resistance varies as the square of the electromotive force with a given number of watts. The preparation necessary in operating such a machine is to prevent the spark from starting. It is like the smoke nuisance. The way to get rid of the smoke is not to produce it. The same way with sparking, and the trouble with that machine is it will not start to spark seriously, because it would cause very serious results. The prevention of sparking in the first place is secured largely by the use of hard carbon brushes, smooth, hardened and fine grained.

Another point is that the tension of the frame must be kept half way between the terminal electromotive force. By that is meant, if the total electromotive force is 10,000 volts between the two brushes, that the frame should be 5,000 volts to a point between it and the positive brush, and the same way with the negative. It is almost necessary to keep that potential at that point. In regard to how to keep it there, Mr. Bradley has a system by which he positively does it, but if the machine is highly insulated it takes care of itself.

As to the application of these machines, Prof. Crocker stated that the purposes to which he had applied them had been ordinary experimental work. For example, one of these machines at 3,000 or 4,000 volts will run a Geissler tube very beautifully. It will produce any other of the so-called electrostatic effects, that is to say, effects produced by very high potential in small quantities. It will, for instance, act very much like an electrostatic machine or a friction machine. In other words, you can get all the electrostatic effects similar to this potential from an ordinary frictional machine.

Another purpose to which the machine is applicable is testing of insulation, and, in fact, that is one purpose for which it was made. It is a very good way to test insulation. It will be asked: Why not use a high potential transformer as being more convenient and not having a commutator? That is not the same test. If the wire is exposed to a direct current strain an alternating current test is not proper. If a wire is subjected to a direct current strain it should be subjected to a direct current test. If it is subjected to an alternating current strain, it should be subjected to an alternating current test. The other application is, of course, power transmission, and of course it is not necessary to have the total voltage generated by one machine. In any plant no one dynamo should constitute more than a comparatively small fraction of the total plant, and if there are five dynamos in a central station or power transmission station there is no reason why they should not be connected in series as well as in parallel. Each machine can generate a few thousand volts, two to five, and the total voltage can be obtained by the proper series connections of several machines.

On the Carrying Capacity of Electric Cables Submerged, Buried, or Suspended in Air.—II.*

BY A. E. KENNELLY.

Influence of Neighboring Active Cables.—If two or more active cables are buried in the same trench they will exert a mutual thermal influence upon each other, and it becomes important to ascertain in what degree their proximity will influence their temperature elevations and safe carrying capacity.

As an illustration of the distribution of temperature communicated to the soil in the vicinity of an active cable, Fig. 2 represents the special case of a cable whose axis is buried 40 radii below the ground surface. If the external diameter of the cable should be 5 centimetres (1.97 inches), the depth will correspond to 1 metre (39.37 inches). Taking the temperature elevation at the external surface, or sheath, of the cable as standard, the circles indicate the sections of successive isothermal surfaces, having 95 per cent., 90 per cent., 85 per cent.—10 per cent of the sheath elevation, the ground surface being the postulated surface of zero elevation. It is evident that for a given distance from the cable the temperature elevation is highest immediately beneath and lowest immediately above it. Table No. II. gives the horizontal distances at which these isotherms occur, measured from the cable axis, and this series is represented by the curve in Fig. 3.

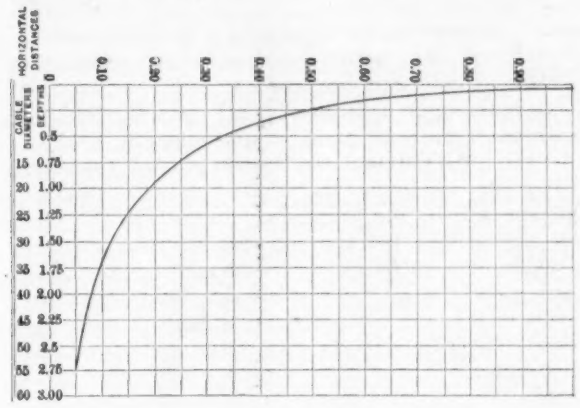


FIG. 3.

These entries and diagrams by representing a dimensional system of common occurence in practice may enable temperature elevations at different distances from an active cable determinable in some cases by direct inspection. The data, however, for constructing the diagram corresponding to Fig. 2 appropriate to any given case are provided in Appendix II.

In this case, if the temperature elevation at the cable's sheathing should be 10 degrees centigrade, and a second cable should be placed in the same trench and parallel to the first at an interaxial distance of 22.7 centimetres, the table and curves show that the second cable would have its temperature raised by 50 per cent. of that at the sheath of the first, namely five degrees centigrade, and if 25 degrees centigrade constituted the limiting safe temperature elevation above normal, then the limit of self-elevation allotted to the second cable would be reduced to 20 degrees. The same process might be extended to any number

TABLE II.

Per cent. of sheath elevation.	Horizontal distance from axis. Cms.	Horizontal distance from axis. Cable diameters.	Per cent. of sheath elevation.	Horizontal distance from axis. Cms.	Horizontal distance from axis. Cable diameters.	Per cent. of sheath elevation.	Horizontal distance from axis. Cms.	Horizontal distance from axis. Cable diameters.	Per cent. of sheath elevation.	Horizontal distance from axis. Cms.	Horizontal distance from axis. Cable diameters.
95	3.15	0.63	70	9.40	1.8	45	28.28	5.6	20	91.8	18.4
90	3.92	0.784	65	11.71	2.3	40	35.38	7.1	15	121.5	24.3
85	4.88	0.976	60	14.58	2.9	35	44.58	8.9	10	169 1	33.8
80	6.07	1.21	55	18.16	3.6	30	56.0	11.2	5	269.6	53.9
75	7.55	1.5	50	22.65	4.5	25	71.2	14.2			

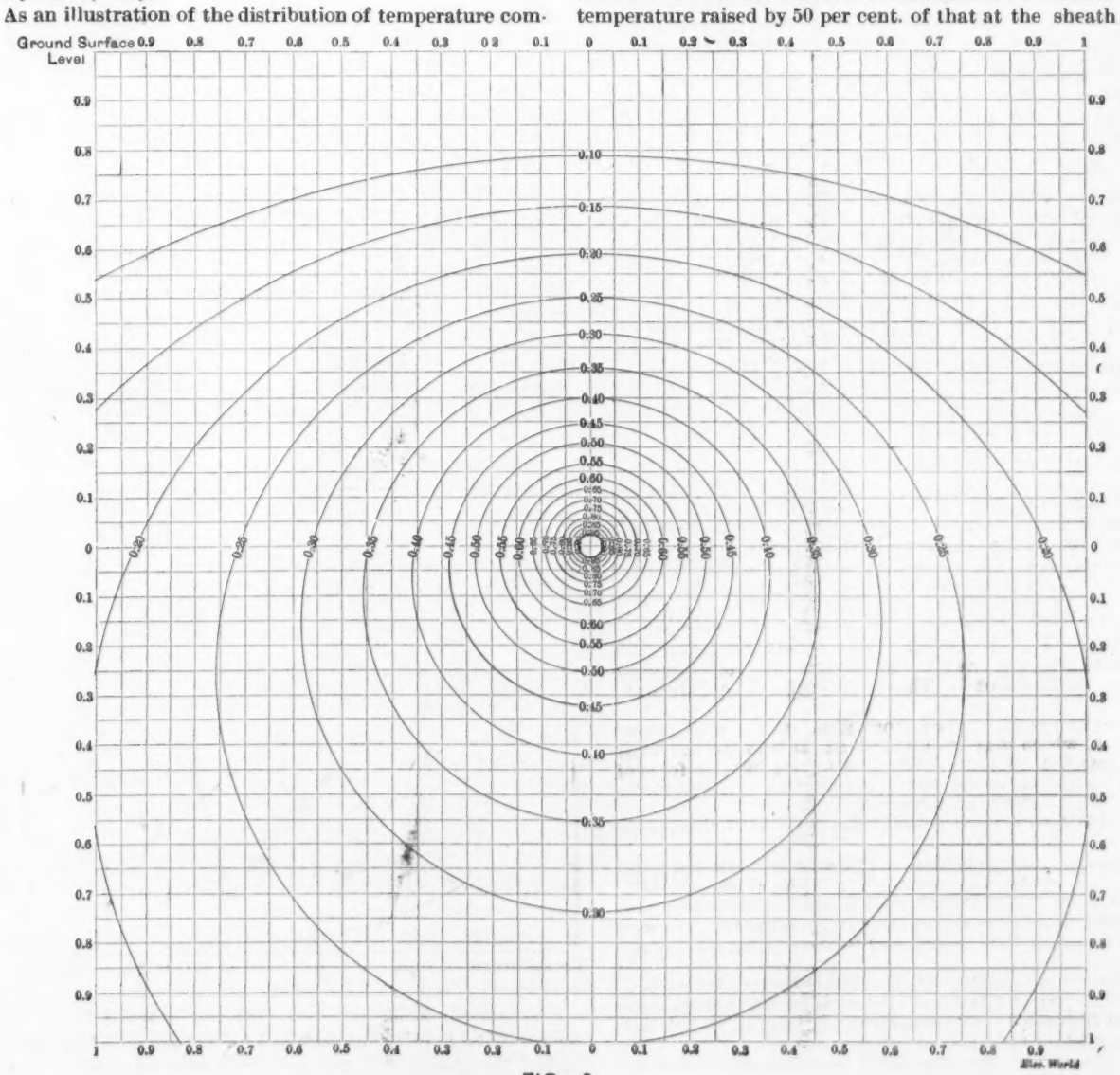


FIG. 2.

* Paper read before the Association of Edison Illuminating Companies at Chicago.

of cables buried in one trench. A diagram could be prepared showing the relative positions of the cables, and the elevation of any one would be the sum of the elevations due to all the remaining active cables taken in turn as though each acted alone. This sum would represent for that cable the total elevation above normal due to mutual influence, and should be subtracted from the range of self-elevation in assigning the limiting current strength. This proceeding not only involves the previous assumption that the temperature elevation of the ground surface is negligible, but also that the insertion of parallel idle cables into an otherwise homogeneous environment does not affect the thermal distribution previously existing. This of course could be only true for cables of infinitesimally small cross section. The effect of the location of a sheathed cable in the vicinity of other active ones must be to equalize the temperature throughout the space it occupies, and this tendency must exert a disturbing influence, diminishing with distance, over all parts of the thermal field of distribution. The nearer the cables are packed together, and the greater the ratio of their diameters to their depths, the greater will be the discrepancy due to both these incorrect assumptions, but it would seem that for ordinary sizes, depths of from 60 to 120 centimetres (2 to 4 feet), and distances apart of 30 to 90 centimetres (1 to 3 feet), this error will not be serious. Observations made on cables horizontally separated by 11.4 diameters in the same trench showed that the temperature of one kept inactive acquired in three hours 38 per cent. of the temperature elevation at the sheath of its active neighbor, the calculated elevation being 42%.

Fig. 3 gives the temperature elevation at horizontal distances in the soil measured from a buried cable, the depth of whose axis is 20 diameters. The ordinates are the ratios of the temperature elevation to that of the sheathing, and the abscissae the horizontal distances from the cable axis in both depth—distance and cable diameters. The curve shows that for the depth there considered the temperature elevation at a horizontal distance of 20 diameters is less than 20 per cent., while at five diameters it is nearly 50 per cent. of that at the sheath of a continuously active cable. With heavy cables, maintained for long periods of load in soils of high thermal resistivity, their distance apart in the trench may thus become an important matter.

Influence of Duration of Load Upon Temperature Elevation.—The temperature elevation of a cable with a given steady current, in the sense ordinarily intended, is that maximum elevation which is only attained after an indefinitely long period of activity. The problem of the temperature development throughout time, in and round a buried cable, may be solved on the postulate of a constant normal temperature of the ground surface, by considering two equal and parallel cables in the same vertical plane, and at a distance apart of twice the trench depth, but with the ground now distributed round them for an indefinite distance in all directions. If the lower cable generates heat at a given rate, and the upper cable absorbs (or generates negative heat) at the same rate, the temperature of the mid-plane between them, corresponding to the actual surface of the ground, must remain by symmetry undisturbed, and the distribution of temperature below this plane due to the independent temperature distributions from both cables, advancing with time, will in algebraic sum correspond to the distribution developed by the actual cable. The problem therefore reverts to that of determining the distribution of temperature in an indefinitely extended medium surrounding a long straight cable steadily supplying heat, and the materials for the solution of this case have been supplied by Fourier. It would appear that under practical conditions the temperature elevation in and near the cable tends to reach its maximum with comparative rapidity, the approximation to the final state being more tardy as the distance from the cable increases. In the measurements of the temperature elevation of buried samples the elevation of sizes up to 200,000 circular mils (1.014 square centimetres) appeared to attain 95 per cent. of their full value in the conductor within 20 minutes, and the increase became inappreciable after one hour. On the other hand, while, as already remarked, a parallel idle cable, 11.4 diameters horizontally distant, reached 38 per cent. of the active cable's sheath temperature in three hours out of 42 calculated, another idle cable at 22.8 diameters appeared to reach only 17 per cent. out of a calculated 29 per cent. in the same period, a discrepancy that may well have been due to time lag. It may, therefore, be safe to infer that the conductor of a buried cable will closely approximate to its ultimate temperature elevation in one hour of steady load; but there can be little doubt that many hours will be needed to establish an equal approximation to the final state at a distance of, say, 40 diameters from the cable.

Carrying Capacity of Cables in Air.—Although the condition of an active cable supported in air is only a special case of the general heating of aerial conductors, yet it merits separate consideration owing to the comparatively high thermal resistance of the insulating covering in such cables, and the leading influence of this resistance upon the carrying capacity.

The current strength that will elevate the temperature of the conductor θ degrees centigrade, when supported horizontally in air, is

$$C = \sqrt{\frac{\theta}{\rho\left(S + \frac{1}{\varepsilon}\right)}} \qquad (11)$$

where ε is the total emission of heat from the external surface per linear centimetre, by convection, radiation and wind, per degree centigrade of temperature elevation there existing. As the temperature elevation of the sheath will in practice be less than 20 degrees centigrade, ε may be taken as constant within that range, and as being expressed by the equation

$$\varepsilon = 0.00111 \times O + 0.00175 \qquad (12)$$

where the first term on the right hand refers to the radiation, O being the external circumference in centimetres, and the second term to convection. The cable is supposed to be supported in still air. These constants appear to satisfy the observations very fairly.

Also $\frac{1}{\varepsilon}$ may be regardedas the equivalent thermal resistance of the air round the cable under these circumstances, corresponding to the resistance G of the soil in a buried cable.

Example: The cable previously considered, instead of being buried is supported in still air. Required the limiting current. Here O = 3.23, and $\varepsilon = 0.005335$. $\frac{1}{\varepsilon} = 187.4$. The total thermal resistance is 81.36 + 187.4 = 268.76, and $C = \frac{5}{\sqrt{0.000009417 \times 268.76}} = 99.42$ amperes.

It appears that $\frac{1}{\varepsilon}$ is greater than G in most cases that are likely to occur in practice (exceptions occur in heavily insulated cables), so that the thermal resistance to the escape of heat from a cable is usually less when the cable is buried than when supported in still air. Consequently the temperature elevation will be the greater in the latter case for a given current strength. Also, if a cable is first supported in the air of a vault, and then enters a trench, there will be no overheating of the buried portion by load, if it is known that the unburied portion is within the safety limits of temperature elevation, and the temperature of the sheath in the buried portion will be lower than the temperature of the sheath in the vault, assuming that the normal temperature of the soil and of the vault are equal.

Thermal Resistivities.—Comparatively few measurements have been made of the thermal resistivities of bodies. They are known to be functions of the temperature of the substance. There is also reason to believe that good heat conductors conduct better, and good heat insulators insulate better at low temperatures,* in analogy to the electrical properties of similar materials. In the absence of better information the resistivities taken in dealing with these cables are assumed to be constant throughout the range of temperature employed.

APPENDIX I.—PARTICULARS OF MEASUREMENTS MADE ON SAMPLE.

Siemens Cables.—Four samples of Siemens cable, each about 30 feet long, were employed, viz.: No. 12 B. & S., No. 6 B. & S., 80,000 cir. mils and 200,000 cir. mils. The last two had stranded conductors.

The insulator was jute soaked in special compound. The sheath was a cold rolled leaden tube fitting over the insulator.

Each cable was tested three times, once in flowing water, once supported in still air, and once buried in the ground.

In the first test the cable occupied an iron pipe 880 centimetres long, and 3.3 centimetres internal, 4.1 centimetres external diameter, resting upon the ground upon a slight incline. Short right-angle pieces were attached vertically to the ends of the pipe, and water was kept flowing through this pipe with sufficient velocity to maintain the temperature of the water within one degree centigrade at ingress and egress. The mean of the water temperatures at the two ends was assumed to coincide with the mean temperature of the sheathing. Measured currents were delivered through the cable, and the resistance of the conductor measured by differential galvanometer in comparison with a platinoid standard. The increase of resistance in the conductor covered by the pipe gave by Matthiessen's table of temperature coefficients the temperature elevation of the copper. The electrical connections were practically the same as those described and illustrated in the report upon the heating of conductors submitted at the Convention of Edison Illuminating Companies at Niagara Falls in August, 1889. From these temperature elevations, measured current strengths, and the dimensions of the cable, the thermal resistivity of the insulating material was determined.

In the second test the cable was supported in still air, the remaining conditions being otherwise unchanged. The temperature of the sheath was measured with thermometers as a check upon the computed values.

In the third test, all four cables were buried at a depth of 76 centimetres in sandy soil, and parallel to each other in the same trench, the axis of adjacent pairs being 16 centimetres distant. The length of each cable resting on the bottom of the trench was 720 centimetres, 90 centimetres being required at each end for the ascent to the surface of the ground. Pressure wires were soldered to the conductors at the upward bends, so that only the resistance of the lengths at the full depth was measured. The same method of testing was employed throughout. The approximation to final temperature elevations was rapid in the water-covered samples, the increase in resistance with a given current being almost inappreciable after 15 minutes' application. It was somewhat delayed in the tests in air, 25 minutes being generally required, and with the buried samples readings continued to advance until 40 or 50 minutes after application of load.

* Prof. Forbes, l. c.; also Everett's "Units and Physical Constants," article "Heat."

APPENDIX II.—DATA FOR CONSTRUCTING A DIAGRAM OF ISOTHERMAL SURFACE SECTIONS.

Let D be the depth of the cable's axis in centimetres.
R be the external radius of the cable sheathing (cms),
y be the depth of the axis of an isothermal cylinder (cms.)
x be the distance at which the isothermal cylinder intersects the horizontal plane through the cable axis (cms.)
a be the radius of the isothermal cylinder (cms.)
ν be the ratio of the temperature on the isothermal to the temperature at the external surface of the cable.

Then
$$a = \frac{2DB}{B^2 - 1},$$
$$y = D\frac{B^2 + 1}{B^2 - 1},$$
$$x = \frac{2D}{\sqrt{B^2 - 1}},$$
where
$$B = \varepsilon \nu \log_{\varepsilon}\left(\frac{2D}{R} - 1\right).$$

Example: D = 100, R = 2.5, find the isothermal of half sheath temperature elevation, or $\nu = 0.5$.

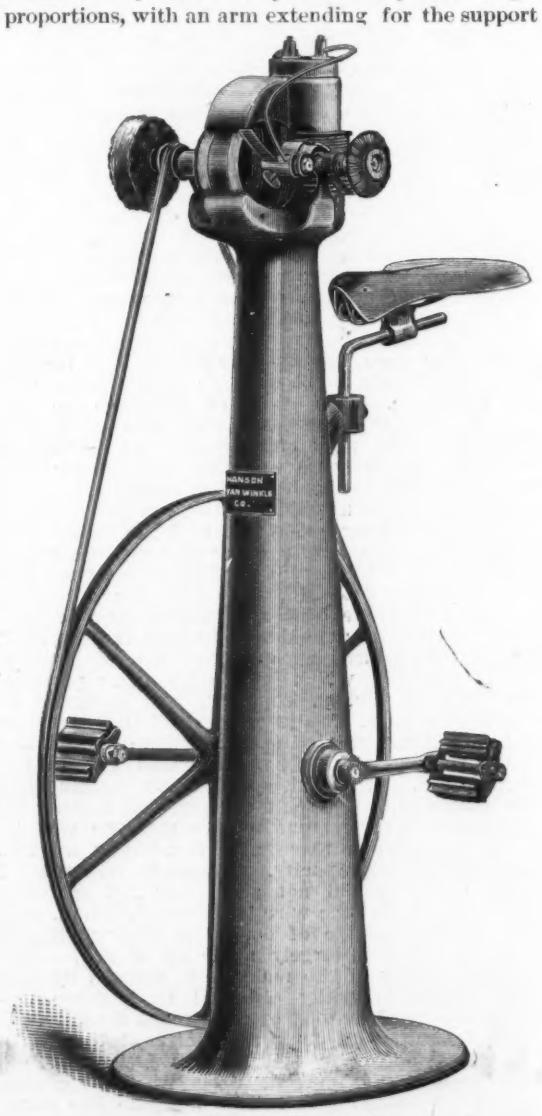
Here $B = \varepsilon\, 0.5 \log_{\varepsilon} 79 = 8.888.$

a = 22.79 cms.
y = 102.6 cms.
x = 22.65 cms.

A Bicycle Dynamo.

The need of a suitable hand or foot power dynamo has often been felt, particularly by those who do electroplating on a small scale, as well as for instruction purposes in schools, and the Hanson & Van Winkle Company, Newark, N. J., has recently placed such a machine on the market, which we illustrate.

The dynamo is a regular machine, similar in construction and principle to the larger machines manufactured by the same firm, and is of the latest style and highest efficiency. It consists of a dynamo cast upon an iron pedestal of graceful proportions, with an arm extending for the support of



A Bicycle Dynamo.

the saddle and hubs in which the main bearing runs. It has short direct poles, a short magnetic circuit, and one field coil. This latter is wound upon a bobbin that is easily taken off; the core is of wrought iron with an extra large magnetic contact. One end of the pole is cast solid to the magnet core, the other cast on a taper, keyed and bolted. The poles have extended arms, which, after being bored and the boxes turned to same diameter and bolted into place, insures perfect alignment for the bushings in which the armature shaft runs. Every part of the machine upon which wear comes is made in duplicate, and is easily exchanged for new parts.

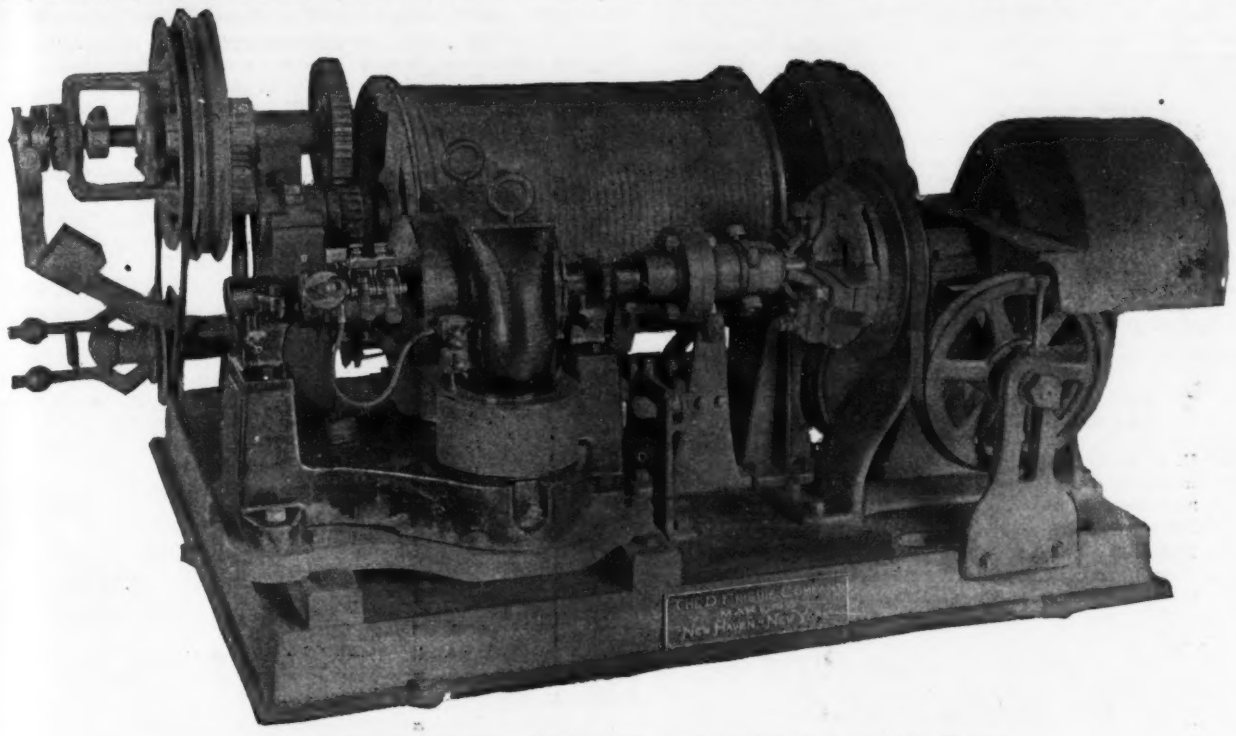
The machine has a regulation bicycle saddle with spring adjustment and an adjustable saddle post, allowing a child or the tallest man to do the work with perfect satisfaction

There are ball bearings, rubber pedals, regulation bicycle cranks and crank pins, all nickel plated.

This machine has also taper holes chucked into both ends of shaft of the armature, in which may be fitted the spindles of buffing and polishing wheels.

A Constant Speed, Direct Connected Electric Elevator.

The invention of a constant speed, direct connected electric elevator that would be practical has been the aim of mechanics and electricians for years past, but there have been some difficult problems to be overcome, among which might be mentioned excessive use of current, the continued annoyance of "blowing out" of fuses, and the "burning out" of armatures. These and other points of importance have been considered in the elevator we illustrate, which is manufactured by the Frisbie Elevator and Manufacturing Company, New Haven, Conn.



THE FRISBIE DIRECT CONNECTED ELECTRIC ELEVATOR.

To overcome the very serious objections of starting and stopping the armature every time the car is operated, the armature of this machine is run at full speed continuously in one direction during the hours of work. By actual test it is found that it consumes a considerable less amount of current than would be used in starting the armature when at a standstill under a load.

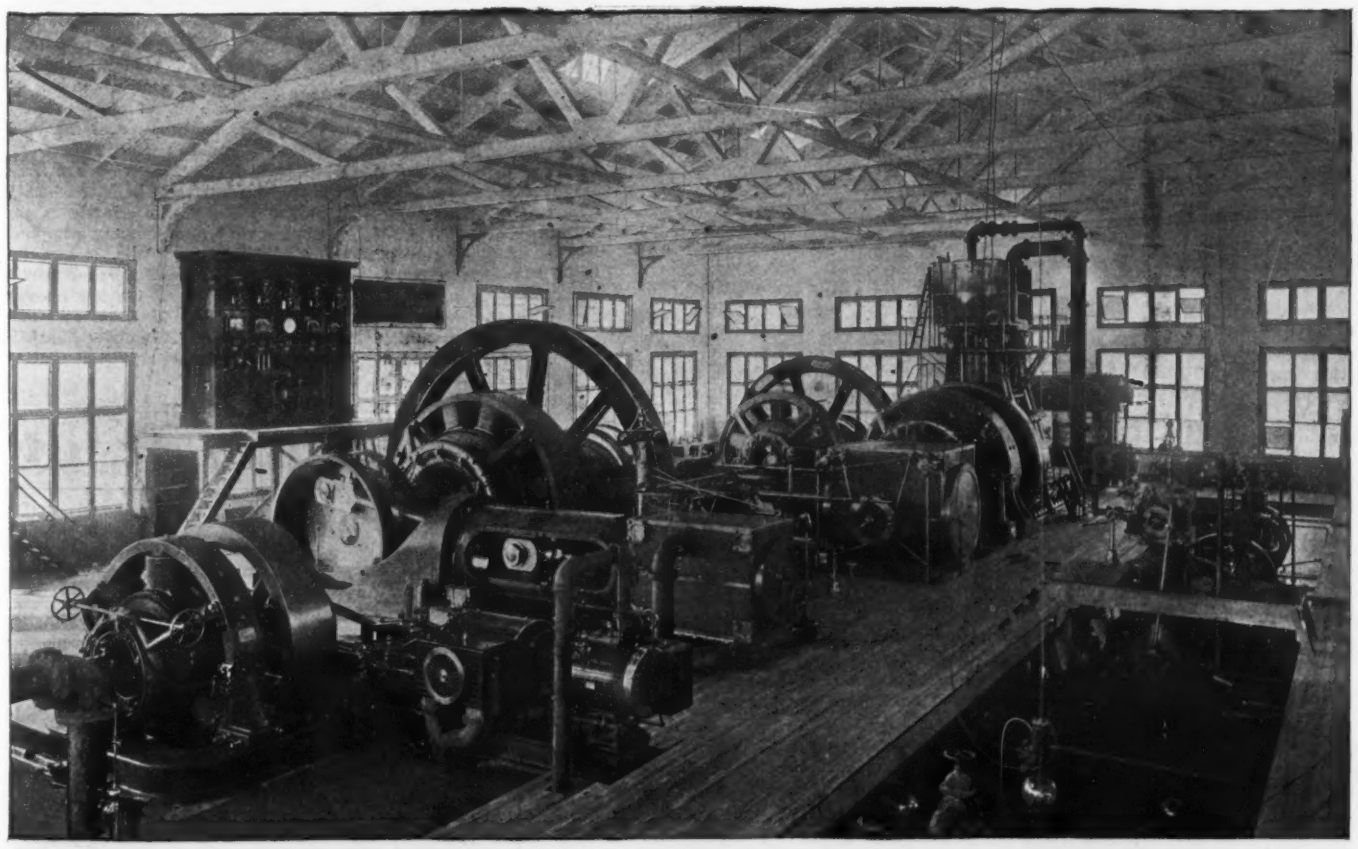
By an ingenious invention, a reversible motion is imparted from the motor to the screw shaft. Two patent friction clutches, one for hoisting and one for lowering, give the operator, in the car, perfect control over the machine, and he can start, stop and reverse it at will. He can also move the car to such a nicety that it can be started and stopped within a fractional part of an inch, a feature whose value will be appreciated. By the stop motion employed on the machine, the car can be run at full speed and is stopped automatically at the extreme travel of the run.

The slack cable stop, in the event of the car meeting any obstruction in its descent, engages a clutch at the end of the drum shaft, stopping the machine instantly, and locking it so that the operator can make no further descent until the machine has been examined and the ropes placed in their proper scores on the drum. In the event of the current becoming impaired for any reason while the car is descending with a heavy load, the speed governor on the machine, operating by means of centrifugal force, throws out the friction clutch, and puts on a powerful automatic brake, which stops a machine instantly.

With a view to reducing the friction to a minimum, an improved Ball thrust collar on the screw shaft s used. The worm is cut from steel of the best grade, and the worm wheel is extra heavy, is machine molded and cast of phosphor bronze, making it very tough and durable. The drum is turned and grooved to fit the wire cables.

These machines, which are used for both passenger and freight elevators, can be run at a high rate of speed, and yet the car can be started and stopped very smoothly.

Claims made for this elevator are that the electric motor runs continuously in one direction, with a resulting economy in the amount of current consumed, and the load is picked up instead of starting from a dead point. There is an entire absence of intricate, dangerous and expensive resistance boxes and switches, no current is required except what is absolutely necessary to lift the load, and the operator has absolute control over the machine, being able to handle the car to a nicety. The machine is practically noiseless, and the reduction of the friction to the least possible minimum has been accomplished. All of the automatic stops are contained in the machine itself, and, finally, incandescent lights on the same circuit are not affected—a point of especial importance.



INTERIOR VIEW OF THE INTRAMURAL RAILWAY POWER STATION AT THE WORLD'S FAIR.

The Intramural Railway at the World's Fair.

The accompanying illustration gives a view of the power station of the General Electric Company's plant which operates the Intramural Railway on the World's Fair grounds at Chicago. It gives a general idea of the arrangement of the engines and generators, and perhaps shows some details which were not brought out in the very elaborate description of this railway which appeared in The Electric World of May 6, 1893.

A Correction.

In an article in last week's issue describing an improved lamp shade, through a slip of the pen the name of Mr. Chas. E. Chapin was given as Mr. A. C. Chapin. As, however, the correct address, 136 Liberty street, appeared, there is little likelihood that any one was deceived in regard to the identity of one so well known in connection with that address as Mr. Chas E. Chapin.

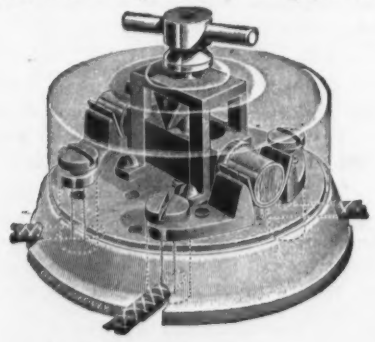
A Novelty in Electric Lighting.

From the earliest days of the commercial application of electricity to electric lighting the designers of lighting apparatus, including both generators and lamps, have sought to secure the maximum economy by maximum efficiency, and as a result the dynamo of the present day is a very efficient machine, and the lamp, both arc and incandescent, has also reached a comparatively high state of development. Economy, however, is still sought in other directions, and it is but natural that inventors should have turned their attention to other means of accomplishing the desired end. A very ingenious device has been originated by Mr. S. L. Trippe, of New York City, and patented in this country and abroad, for which most remarkable results are claimed. The idea has been suggested before, but Mr. Trippe has taken it up from the practical standpoint and actually worked out a system which is in operation at the present time and has been for many months. The principle is very simple. Instead of arranging incandescent lamps on one circuit or branches and feeding them continuously from the same source they are arranged on any number of separate circuits, say four, and the current is alternately switched from one to the other in regular succession, the idea being that the current, having heated each successive circuit of lamps to incandescence, will be returned again to that series before the lamp filaments have time to cool.

The means by which this is accomplished is the employment of a special interrupter or rotating cylinder, on which the segments are so arranged that a system of brushes, with which they make contact, carries the current alternately to each series of lamps. It is evident that the period of its current or the number of times per second which it passes through a given set of lamps can be made almost anything, depending upon the construction of the interrupter and its number of revolutions. In this device it was somewhere about 70 per second. The induction currents are utilized in feeding a separate circuit of a few lamps, which, it is claimed, also serves to prevent sparking. The loss of energy in the commutating or interrupting device is, of course, to be considered, but Mr. Trippe claims that between two and three times as many lamps can be operated from a given source of energy as with any of the other systems in use to-day. The interrupter can be run by a steam engine, a motor or any other source of power. The system has been experimentally tried in one of the largest buildings in New York City, and as it was necessary to largely increase the capacity of the plant there installed it has been decided to introduce the invention of Mr. Trippe. The result of the experiment will be watched with interest, as the only true way to test the merits of any system is to subject it to the varying conditions of practical, every-day use

A Snap Switch.

The switch we illustrate, known as the New England switch, is handled by Wm. C. Callman & Co., 136 Liberty street, New York, and was primarily designed to fill the demand for a switch that is thoroughly reliable and constructed on correct mechanical and electrical principles.



A SNAP SWITCH.

The switch, as will be seen, is neat in appearance, and being strong and simple in construction is unusually durable. The contact brushes are of copper backed up by German silver, which gives the necessary elasticity; they are firmly held between the contact lugs by a cam, thus making an ideal contact, which cannot be released without turning the handle.

The switches are manufactured in sizes from 10 to 100 ampères and are mounted on porcelain bases.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Sept. 1, 1893.

GENERAL ELECTRIC still holds the palm for speculative activity among electrical stocks. Interest in this corporation's career is not allowed to flag from lack of gossip. Boston is responsible for most of it, and from that city comes the following statement, with "a director" as the alleged author of the remarks:

"The board will decide to suspend dividends indefinitely, or until the company can put itself in position to resume payments and maintain them. Barring the fact that times are out of joint and that the General Electric Company suffers correspondingly, there is nothing the matter. It is deemed conservative policy to husband our resources, so payment of dividends will be suspended."

Vice-President Griffin states, however, that the dividend question has not yet come up in any shape before the Board of Directors, and that if any body connected with the company has given expression to such views, it was not in an official capacity; but he was merely stating an individual opinion. Boston reports are very positive, however, in their assertions of trouble in the General Electric Company, and sales of stock during the earlier part of the week are attributed to sources "down East." Inside quarrels are talked of, and the resignation of President Coffin, with a consequent defection of other prominent insiders, is a rumor that has gained a deal of circulation. Nothing has been heard in recent days of the new trust that is to liquidate the company's floating debt. Officials, when questioned, state that it is making progress, but further and more definite information is not vouchsafed. The Drexel-Morgan people proclaim their faith in the property as emphatically as ever, and the support rendered the stock to-day under 39 is positively declared to emanate directly from the big Wall street banking house. Among manufacturers proper the many alarmist stories current regarding the General Electric Company have reacted most unfavorably on the relations existing between them, and the distrust in some quarters is such as to make them loath to take any orders for materials from the General Electric Company. They seem to think the big concern is near its end and are afraid of a smash up. That the necessity of reducing expenses to meet the exigencies of the situation is as acute with the General Electric Company as with any other corporation is evidenced by the fact that arrangements are being made to do away with the district managers. Several have already been notified, it is stated, that their services are no longer required. In the last hour of Thursday's trading unexpected weakness again developed in General Electric, and Wall street was again flooded with reports of an impending receivership. On Friday, the stock, after opening strong with the general market, declined on the resumption of liquidation for Boston account; the closing quotation was, however, 39¼, a gain of over two points. Another cheering feature is the well founded report of a prospect for the early resumption of work on full time at the electrical works at Lynn, Mass., which have been running on short time for some weeks. It is said that many of the workmen who were allowed to go two weeks ago have been notified to report for work. We also learn as we go to press that the General Electric Company has secured a contract for two hundred fully equipped electric cars from one of the Brooklyn trolley lines.

THE FORT WAYNE ELECTRIC PEOPLE are seemingly sincere in their avowed determination to break away from the General Electric Company. To judge from remarks made by the Fort Wayne people, the questions at odds are less likely of settlement than ever, and the quarrel is bound to assume bigger proportions.

WESTERN UNION has been under the hammer to-day, and it loses 1½ points as the result of to-day's transactions. The stock has, however, shown exceptional strength in the face of a continual declining market, but desperate manipulation alone has succeeded in holding its price up. Efforts have been made again and again to materially lower its price, but on every occasion inside support has rallied its quotation. The Broadway people are determined in their effort not to let the bears have things their own way, as they generally do in General Electric, and all raids are resisted with all possible means. The bears on the stock have good grounds for their belief that it should sell lower. The earnings have fallen off tremendously as a result of the terrible depression throughout the country, and on top of this big loss of revenue comes the damage done to the company's property by the fearful storms that raged this and last week. The company's service has been wellnigh paralyzed by these hurricanes of wind and rain. It is still badly crippled. The cost of putting up the wires and poles throughout hundreds of miles of territory will foot up to a large amount. Add to the cost of repairs the loss of business occasioned by the inability of the company to furnish telegraph facilities to would-be customers and the damage wrought by the big storms will prove rather expensive. A curious fact in connection with these storms is that the telephone service, both for short and long distances was not interfered with to any such degree as the Western Union Telegraph Company suffered. The newspaper reports show that nearly all of the wires left working in the storm-swept sections were telephone wires, and these were worked much easier than such telegraph wires as were left standing. This attracts renewed attention to the inroads the long distance telephone is making in the telegraph companies' field. The telephone is daily coming into a greater use as a means of communication between widely separated points. Preparations are being made to extend the system, and a further curtailment of the telegraph companies' revenue is thereby threatened, and the threat is seeming much in the nature of a reality. The ability of the telephone wires to withstand a severe storm so much better than the telegraph system must prove a great advertisement.

EDISON ILLUMINATING STOCK and bonds have been higher. The explanation is that a large block of securities of this company that has been hanging over the market has at length been absorbed here and abroad, and that there no longer is any danger of having large amounts of stock come upon the market to depress prices.

WESTINGHOUSH matters are quiet. The management is devoting itself to make the company as solid as possible, and the ease with which it has weathered the financial gale shows how carefully and wisely the resources of the company have been husbanded. The company has several new inventions of importance on hand, but they will not be pushed to market till the times are more propitious.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	40
Detroit Electrical Works	10	2	3
East River Electric Light	100	..	65
Electric Con. & Supply Co. pref.	15	15	16
" " " " " com	15	15	17½
Edison Electric Ill., New York	100	85	85¼
" " " 1sts	...	99¾	100
Edison Electric Ill., Brooklyn	100	95	100
" " " Boston	100	115	130
" " " Chicago	100	220	230
" " " Philadelphia	100	120	140
Edison Electric Light of Europe	..	2½	5
" Bonds	..	80	85
" Ore Milling	..	5	12
Fort Wayne Electric	..	3	4
General Electric Company	100	37	37¼
" " deb. 5's	..	70	71
Interior Conduit and Ins. Co	100	30	40
Mount Morris Electric	..	..	65
Westinghouse Consolidated	50	20	21
" " pfd	50	39	40

TELEGRAPH AND CABLES.

	Par.	Bid.	Asked.
American District Tel	100	54¾	55
American Tel. & Cable	100	70	71
Central & So. Am. Tel	100	95	105
Commercial Cables	100	137	138
Gold & Stock Tel	100	100	103
Franklin	100	35	40
Mexican Telegraph		180	200
Northwestern Telegraph		102	104
Pacific and Atlantic		50	60
Postal Tel. & Cable		40	60
Southern & Atlantic Tel	25	75	82½
Western Union	100	78¾	79

TELEPHONE STOCKS.

American Bell		181	182
Erie Telephone		39¾	40
New England Telephone		48	50
N. Y. & N. J. Telephone		90	95
Metropolitan Tel. & Tele Co		200	....

AFFAIRS OF THE COMPANIES.

THE H. C. FISH MACHINE WORKS, Worcester, Mass., has added an electrical department to its business, and will in the future manufacture the H. C. F. dynamos and motors. Mr. E. H. Fish has been placed in charge of this new department.

THE FRISBIE ELEVATOR AND MANUFACTURING COMPANY, New Haven, Conn., has elected the following officers: S. M. Munson, president; W. M. Frisbie, vice-president and superintendent; Geo. W. La Rue, secretary and treasurer; C. E. Corwin, sales agent.

NEW INCORPORATIONS.

THE ATWOOD ELECTRIC HEADLIGHT COMPANY, St. Louis, Mo., capital stock $125,000, has been formed to manufacture electric lamps, etc. The organizers are L. C. Atwood, E. B. Roth and M. Keber, all of St. Louis.

THE ACME ELECTRIC COMPANY, New York, maximum capital stock $3,000,000, has been formed to do a general manufacturing business, etc. A. T. Sinker, New Dorp, S. I.; A. F. Crawford, W. Haverstraw, and W. A. Crawford, Brooklyn, N. Y., are the promoters.

THE MIDWOOD ELECTRIC LIGHT, HEAT AND POWER COMPANY, of the County of Kings, Flatbush, N. Y., capital stock $50,000, has been formed to furnish light, heat and power. William Matthews, Brooklyn; A. L. Ditmas and J. Z. Lott, Flatbush, are interested.

THE IOWA ELECTRIC AND CONSTRUCTION COMPANY, Des Moines, Ia., capital stock $100,000, has been formed to do a general electrical and supply business. A. T. Hess, J. A. Innes, J. Stedman, E. C. Spinney, E. G. Pratt and William Bowen, Des Moines, Ia., are the incorporators.

THE YOUNGSTOWN, PARK & FALLS STREET RAILWAY COMPANY, Youngstown, O., capital stock $50,000, has been incorporated to operate street railways by electric or other motive power. H. G. Hamilton, M. T. Evans, J. H. McEwen, G. A. Baker and James Hiney are the promoters.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Sept. 1, 1893.

MR. F. G. WATERHOUSE, of Hartford, Conn., was in the city several days this week.

MR. C. HOLTZER, of the Holtzer-Cabot Electric Company, Boston, was in New York Wednesday.

MR. R. E. GALLAHER, of the New York Insulated Wire Company, left last week for Chicago, where he will remain for some time looking after the company's World's Fair interests.

MESSRS. KESSNER & DORRIS, 15 and 15½ Mechanic street, Newark, N. J., who make a specialty of rewinding and repairing armatures of all makes, report business as extremely brisk.

W. A. VAIL, of 136 Liberty street, is now representing the National Electric Manufacturing Company, of Eau Claire, Wis., for both the alternating and direct systems of electric lighting, and is about to close two large contracts for entire electric light plants.

THE ROYAL ARC ELECTRIC COMPANY will, it is stated, locate its factory and laboratory at Netherwood, N. J., where 11 acres of land have been purchased, on which buildings costing $100,000 will be erected. Mr. Louis E. Howard is president of the company and inventor of a new system of arc lighting, which the company will exploit. The offices of the company are at 143 Liberty street, Central Building.

ALBANY, July 22, 1893.

THE APPLICATION of the Stillwater & Mechanicville Railway for an increase of their capital stock from $45,000 to $60,000, necessitated by their recent change from horse to electric power, has been granted by the State Commission.

AN ORDINANCE has been passed by the Common Council giving the chief of the fire department general supervision of the placing of telegraph, telephone, electric light, electric railway and electric power lines in the city. All wires strung in front of buildings which would hinder the firemen in their work will be ordered down.

THE DIRECTORS of the Albany railway have presented $50 to an employe for his presence of mind in a collision. At a recent meeting it was decided to abandon the North Pearl street line north of Clinton avenue. Cars will be run from North Albany to Kenwood, on Broadway; North Pearl street south of Clinton avenue, on South Pearl street. Arrangements are being made to run express trains between Albany and Troy.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., August 31, 1893.

THE MATHER ELECTRIC COMPANY has its factory again in operation.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, Boston, Mass., is about to introduce its new electric telephone.

THE NEW BEACON incandescent lamp, we are informed by the makers, is meeting with large sales. Their factory is working overtime in order to catch up to their orders.

THE ELECTRIC HEATING CORPORATION has reduced its call upon subscribers from $1,000,000 to $500,000, payable on same dates as the original call, or five per cent Aug. 21, and five per cent. Sept. 20. Interest will be allowed at seven per cent. on prepayments.

THE EASTERN ELECTRIC CABLE COMPANY, Boston, Mass., the manufacturer of the well known Clark wire, has added to its property another piece of land, which will give it an entrance on Tremont street. It is also adding to its plant another building which will be constructed of brick, the foundation of which is already built.

THE HAWKS ELECTRIC COMPANY, Boston, Mass., which has recently put on the market the "Hawk" street fixture, an illustration and description of which appeared in The Electrical World of Aug. 5, reports that the trade have made many inquiries, and express the opinion that it is an excellent fixture for the purpose for which it is offered. A pamphlet giving more detailed information than was contained in our article will be mailed upon application. This should interest electric light station managers.

WESTERN NOTES.

OREGON CITY, Ore., Aug. 26, 1893.

THE NEW ELECTRIC LIGHT POWER HOUSE in Chehalis, Wash., was recently completed.

P. F. MOREY, president of the Portland General Electric Company, recently returned to his home in Oregon City after a short stay in New York.

J. R. McCLELLAND recently succeeded C. C. Grimes as superintendent of the Portland and Vancouver division of the Portland Consolidated Street Railway Company's lines.

THE PORTLAND CONSOLIDATED STREET RAILWAY COMPANY has installed ten new car equipments, supplied by the Northwest General Electric Company. The cars are provided with the new "Series K" controllers.

ELECTRIC STORM.—During a recent electric storm which passed over Vancouver, B. C., the wires of the electric tramway connecting that city with Westminster were struck by lightning, and a generator was damaged in the power station. The Pacific Northwest is so free from thunderstorms ordinarily that the lightning arresters are very seldom connected when an electric plant is installed.

THE TACOMA LIGHT AND WATER COMPANY'S water and electric light plants have been turned over to the city of Tacoma, and are, for the present, in charge of the board of public works. Numerous applications for positions have been filed, but there are very few to be granted. All night arc lights will cost $15, and midnights $10, according to the city's tariff, a reduction of $1.

THE STOCKHOLDERS of the Portland General Electric Company, at a recent meeting, voted to authorize the issue of $2,500,000 first mortgage bonds in lieu of the existing coupon notes. They also authorized the conveyance of the electric railway from Oregon City to the Tualatin River to the recently organized Willamette Falls Company. Sylvester Farrell was elected a director in the place of William S. Ladd, deceased. The company has just secured three patents to islands in the Willamette River, in Oregon City, giving the company complete control of the water power of the Willamette Falls. It has also been pushing the work upon the foundations of its new power house in Oregon City ever since the river has been low enough to permit the coffer dam to be constructed. Material and machinery are constantly being received for the new station, which will be needed as soon as completed, the present station being taxed almost to its full capacity already.

News of the Week.

ELECTRIC LIGHT AND POWER.

STILLWATER, MINN.—At a meeting of the Council the City Clerk was authorized to advertise for bids for lighting the city.

BORDENTOWN, N. J.—The Bordentown Gas Light Company is contemplating the erecting of an electric light plant in that city.

CLIFTON SPRINGS, N. Y.—The voters will decide Aug. 21 in the matter of voting a franchise to a firm which proposes to put in a $5,500 plant for street and general lighting.

MOUNT PLEASANT, PA.—A new electric light company is being organized by Marion Rumbaugh and others who promise to give much cheaper rates than the present company. They have secured 1,000 lights to start with.

MEDFORD, ORE.—Messrs. Sprandle & Sharpp will remove the machinery of the old electric light plant from Roseburg to Medford, and establish a system there. A new 650-light incandescent dynamo will be substituted for the one used here.

NEWBURYPORT, MASS.—The Committee on Streets and Public Buildings has been instructed to inquire into the expediency of lighting the City Hall by arc or incandescent electric lights, and to report on the same at the next meeting of the City Council.

SANTIAGO, CHILI.—The city of Santiago, in Chili, invites proposals for the lighting of the streets and public squares of the city by electricity, to be received to 1 p. m., Dec. 30, next. All details to be had at the Consular offices of Chili, at Philadelphia, Boston or Chicago.

MUNCIE, PA.—The Town Council has granted a franchise for electric lighting to the Muncie Electric Light Company,

which is compose of Muncie business men, with Henry Lenhart, of Philadelphia, as electrical engineer. Work will at once be commenced. Five thousand dollars worth of stock has been subscribed.

THE NORTHPORT (N. Y.) WATER-WORKS COMPANY expects very soon to put in a system of electric lighting, the franchise for lighting the streets in the school district having been granted to it by the town board. Many commercial lights are already subscribed for. Messrs. J. W. Olmstead, Northport, and J. C. Mills, of the Patchogue Electric Light Company, are the purchasing agents.

CEDAR RAPIDS, IA.—Only one bid was received for the city electric lighting. The following report was accepted and the bids were declared off until the further pleasure of the Council: "Inasmuch as the agents of two of the largest of the electric light companies urge a postponement of the award of contract to a later date and intimate that lower prices can then be obtained, the board respectfully submits that this is a matter for the consideration of the honorable City Council. Board of Public Works, J. L. Hardwick, Chairman.

THE ELECTRIC RAILWAY.

NIAGARA FALLS, N. Y.—The Lock City Electric Railway Company has asked Common Council to extend the time for completion of the road from Sept. 1 to May 1, 1894, but it is not likely that any extension beyond Dec. 1 will be granted.

HARRISBURG, PA.—The stockholders of the East Harrisburg Passenger Railway Company have voted unanimously to increase the capital stock from $500,000 to $1,000,000 to make extensions to the present system, provide feeders and complete the system in other ways.

WASHINGTON, D. C.—The Bridgewood Street Railway Company will issue $100,000 in bonds, bearing six per cent. interest, to construct a branch of its railway in Washington, D. C. These bonds will form part of a mortgage of $350,000 on the company's rolling stock, power house, etc.

MONROE, MICH.—J. H. Dawson, of Toledo, O.; H. H. Johnson, of Philadelphia, Pa., and J. H. Warner, of Brooklyn, are in the city making arrangements for an electric road to be built on the old plank road between Toledo and Detroit. The right of way from here to the State line has been obtained.

WASHINGTON, D. C.—The Washington & Arlington Railway Company contemplate an extension of their road, as they have had a bill introduced in the form of an amendment to their incorporation act, authorizing them to build a road to a point opposite the Three Sisters, where the incorporators are privileged to build a bridge across the Potomac, thence to the Arlington Cemetery. The incorporators of the company are: W. H. Randall, D. C. Forney, J. L. Lawrence and James L. Barbour.

PITTSBURGH, PA.—The proposed Pittsburgh & Mansfield Electric Railway Company proposes to bridge the river at Ferry street to the opposite hill and carry an electric line thence to Mansfield. It is expected that this will involve an expenditure of $1,000,000 at least. There will be a passenger station at Water street, travelers being carried by elevators. Elliott Holbrook has been elected president of the company, C. I. McDonald is secretary, E. K. Morse, engineer, and Julian Kennedy is consulting engineer.

NEW KENSINGTON, PA.—Two companies have applied for charters and are practically controlled by the same people. One asks for a street railway franchise and the other for a street lighting franchise. The one is called the Allegheny Valley Traction Company, and the other is the New Kensington Electric Light Company. Among those interested are V. Neubert and Orr Buffington, of Kittanning, Pa., and M. D. Weyman, of Ford City, Pa. It is proposed to run the street railway from Parnassus to Natrona, connecting both sides of the river by a bridge at Valley Camp. The traction company will also erect a bridge there, to be thrown open as a toll bridge. Engineers are now at work making plans and surveys.

Trade and Industrial Notes.

MESSRS. REGER, ATWATER & CO., 214 Pine street, San Francisco, Cal., have been appointed sole agents for the Phoenix incandescent lamp and other electrical specialties handled by Messrs. Wm. C. Callmann & Co., 136 Liberty street, New York.

THE GENERAL ELECTRIC COMPANY has just closed a contract with the Brooklyn Heights Railroad Company, of Brooklyn, for 200 electric car equipments, comprising the new G. E. 800 motor and the latest type of series parallel controller. This contract was secured in the face of considerable competition.

THE GARTON DANIELS ELECTRIC COMPANY, Keokuk, Ia., report that the Panama Electric Street Railway Company, of Panama (U. S. of Colombia), after a thorough trial, has decided to equip its cars throughout with the Garton street railway lightning arrester, and that the equipment was shipped this week.

MR. JOSE ELIGIO MOSQUERA, of Havana, Cuba, dealer and importer of electrical supplies and apparatus, in a recent communication to The Electrical World, regarding electrical matters in Cuba, states that he has the exclusive agency for the Perret system, which is giving the best of satisfaction and excellent results.

GEORGE CUTTER, The Rookery, Chicago, sends us a neat and well printed little pamphlet entitled "Echoes from Electricity Building," which among other things contains reproductions of some of the bright advertising cuts for which Mr. Cutter is so well known. Among these are the ones entitled "Why don't that lamp drop?" and "Nothing like a good shade."

THE BRYANT ELECTRIC COMPANY, Bridgeport, Conn., has issued another edition of its illustrated price list of electrical specialties for incandescent lighting, which contains a number of additions. The switches, sockets and cut-outs made by this firm are so well and favorably known as to require no special mention. The catalogue is handsome and well printed on fine paper, and the cuts are unusually well engraved.

THE FRISBIE ELEVATOR AND MANUFACTURING COMPANY, New Haven, Conn., reports that among its most recent installations the following are a few of the most important: Seven elevators for the United Dressed Beef Company in their new abattoir building, Forty-fourth street and First avenue, New York City; two for the Constitution Wharf Company, Boston, Mass.; one for Cumner, Jones & Company, corner Chauncey street and Row place, Boston, Mass.; one for Hull Brothers & Co., wholesale grocers, Detroit, Mich.; two for S. E. Olson & Co., a large drygoods house in Minneapolis, Minn.; one for S. F. Myers & Co., 51 Maiden Lane, New York. Its factory is now running full time and full handed in filling orders that are coming in almost daily; and provision for increased facilities has had to be made in order to accept the large amount of business that is being offered.

Business Notices.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

DESK ROOM in the commodious office of THE ELECTRICAL WORLD, in the new Monadnock Block, Chicago, may be obtained by applying in person or by letter to the office, 936 Monadnock Block.

PLAYING CARDS.—You can obtain a pack of best quality playing cards by sending fifteen cents in postage to P. S. Eustis, general passenger agent C., B. & Q. R. R., Chicago, Ill.

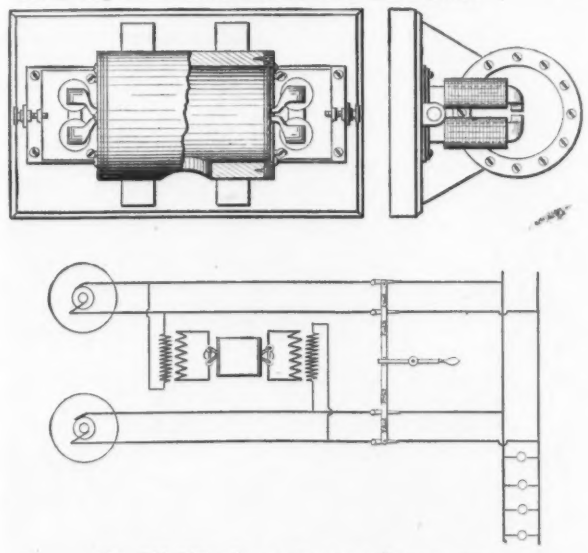
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED AUG. 8, 1893.

(IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N. Y.)

502,695. SYNCHRONISM INDICATOR; Louis Bell, Boston, Mass. Application filed Dec. 24, 1892. This method of indicating synchronism or lack of synchronism between two or more electric machines of the alternating current type consists in setting up by the magnetic effects of the currents of such machines distinctive series of sound waves corresponding respectively in periodicity with the current waves of such different machines, which sound waves, by their interference, if unequal in period, give rise to beats, and thereby indicate audibly the presence or absence of synchronism. (See illustration.)

502,702. ELECTRIC LIGHTING SYSTEM; C. C. Chesney, Pittsfield, Mass. Application filed April 3, 1893. The combination with a generator of alternating currents of one or more incandescent lamps and a condenser associated in parallel in the circuit of the generator, one or more arc lamps also connected with such circuit, and a condenser associated with each of the arc lamps and of a capacity or value to neutralize the self-induction of such lamp and prevent the extra drop in the electromotive force due thereto.



No. 502,695.—SYNCHRONISM INDICATOR.

502,734. FIRE ALARM APPARATUS; S. W. Ludlow, Madisonville, O. Application filed Nov. 5, 1892. An alarm actuating device operating by concussion, connected to an air or gas pipe, and a thermostat containing an expansible medium having communication with the pipe and held normally inactive by a fusible medium, whereby upon melting of the fusible medium the expansible medium is set in operation and an impulse is imparted through the pipe by compression or concussion of its contents.

502,749. CIRCUIT CLOSER; A. J. Oehring, Chicago, Ill. Application filed Feb. 7, 1889. The base of a push key provided with a seat upon which rests a block of insulating material carrying the contacts of the key, a removable cap, locked to the base by a spring carried upon the base and engaging with a portion of the cap and adapted to be depressed by the insertion of a wire to unlock the cap, this cap being provided with a knob which is adapted to be pressed against a spring forming one of the contacts to close the same.

502,753. ELECTRIC BODY WEAR; W. H. Payne, Philadelphia, Pa. Application filed Feb. 18, 1893. A remedial battery and electrode, comprising a band or annulus having a gap or hiatus and consisting of superimposed strips of electro-positive and electro-negative materials separated from each other by interposed insulating material, and the edges of the external strip and insulating layer being folded inward onto the internal strip, and the insulating layer and internal strip being perforated, whereby the strips contact with the skin of the wearer.

502,768. TEST CIRCUIT FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Dec. 27, 1886. The combination of springjack switches, one switch on each of the multiple boards, connections from the subscriber's line to the frame of each springjack switch, a branch circuit through the springs and contact points of the jacks to ground, the operator's telephone circuit, including battery and switching apparatus for connecting the telephone circuit to the line and breaking the branch circuit to ground, whereby the operator can determine whether a line has been previously connected at any other board.

502,769. LOCK SWITCH FOR ELECTRIC SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Nov. 19, 1887. A plug socket, a movable pin inserted therein, a spring which normally holds the pin extended, a detent which locks the pin in this normally extended position, and a connecting plug provided with a clamp adapted to fit over the pin to move it.

502,770. TELEPHONE EXCHANGE APPARATUS; C. E. Scribner, Chicago, Ill. Application filed Oct. 15, 1888. The combination with two telephone line wires extending from a sub-station to a central station, of terminal springjacks upon each of two switchboards connected with both line wires, an annunciator upon each of the switchboards connected to different line wires, and contact points included in both lines adapted to be separated by the insertion of a plug in any springjack, whereby both annunciators are disconnected when a connection is made to the line.

502,771. TRANSFER SYSTEM FOR SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Oct. 27, 1890. The combination with a transfer line of a signaling circuit normally closed at the sending end, but adapted to be opened when connection is made with the transfer circuit at that end, and normally open at the receiving end, but adapted to be closed when connection is made to that end of the signaling circuit, an indicator at the receiving end, and a source of electricity in the signaling circuit.

502,773. TESTING SYSTEM FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed June 29, 1891. The combination with a series of test rings electrically connected together, of a polarized responsive device having two coils adapted to act upon a pivoted armature, a branch extending through both coils in series to earth, a branch extending through both of the coils in parallel and including a battery.

502,774. TEST CIRCUIT FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed July 7, 1891. In combination, telephone lines extending from a sub-station, springjacks having line springs connected to one of the lines, and test rings connected to the other of the lines, and a condenser included in the circuit between the rings of the springjacks and the line to the sub-station.

502,775. TESTING APPARATUS FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Aug. 1, 1891. An electromagnet and a movable armature therefor, a resonant body adapted to be struck by the armature, microphone contacts bearing upon some vibrating portion of the resonant body, and a local circuit inclosing a battery and the microphone contacts and adapted to act inductively upon a telephone.

502,776. ELECTRIC BELT; Jean H. Se Cheverell, Jefferson, O. Application filed June 15, 1892. This is composed of battery cells composed of a plate of copper provided with an open loop and incased in felt or equivalent material with a zinc plate clasping the exterior of the felt, in combination with the spring hinge connection connecting the copper of one cell with the zinc of the next.

502,777. ALTERNATING ELECTRIC CURRENT GENERATOR; S. Sheldon and J. J. Rooney, Brooklyn, N. Y. Application filed Sept. 28, 1892. A dynamo consisting of relatively movable sets of polar extensions respectively of different constant polarities, and a stationary electric conductor within inductive action of the same and extending alternately to opposite sides of the successive extensions of one set.

502,788. REGULATOR FOR ELECTRIC GENERATORS; Elihu Thomson, Swampscott, Mass. Application filed May 23, 1892. The combination with a dynamo, of a separate exciter, and means whereby a portion of the field winding of the exciter is rendered operative or inoperative by the change in potential of the main circuit.

502,804. ELECTRIC BELT; E. P. Andrus, St. Louis, Mo. Application filed Oct. 31, 1892. In an electric belt an electrode having its edge turned, a lip formed with the same, and a steel bar, one end of which is adapted to be received by the edge and the other end by the lip, leaving a space between the bar and electrode for the belt.

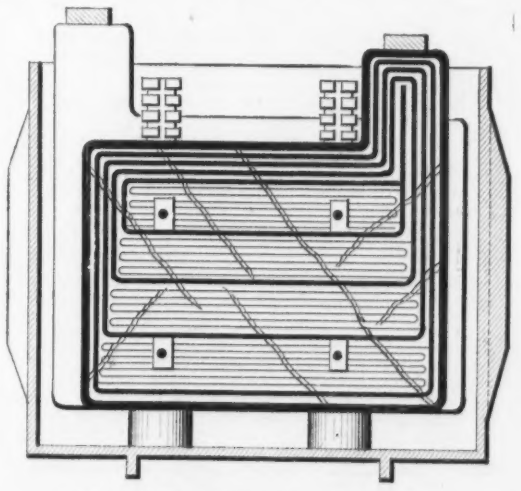
502,811. ELECTRIC ALARM CLOCK; W. H. Deane, Brooklyn, N. Y. Application filed Dec. 15, 1892. The combination with an alarm clock of a vertical rod, a weighted circuit closer adapted to slide freely on the rod, an extension of an arbor of the alarm mechanism adapted to normally support the circuit closer and to release it when the alarm mechanism is set free, and an electric circuit including a battery and electric bell, the terminals of which are closed by the weight when it descends.

502,821. SUBWAY FOR ELECTRIC RAILWAY CONDUCTORS; L La R. Johnson, Washington, D. C. Application filed Oct. 10, 1890. A subway for railways, having one side edge provided with longitudinal flanges for attachment to the ties, the opposite side being prolonged and supporting a guard plate.

502,824. SECONDARY BATTERY; L. Morse, Brooklyn, N. Y. Application filed July 25, 1892. The combination of a positive electrode, a negative electrode, and an insulator between them consisting of a standard having vertical grooves, and grooves intercepting them in their sides. (See illustration.)

502,825. ELECTRIC SWITCH; L. Morse, Brooklyn, N. Y. Application filed Aug. 22, 1892. In a circuit controlling device or switch, the combination of a horizontally sliding switchbolt, with circuit terminals in line with the bolt, each terminal having a trough-like jaw, a pivoted jaw provided with teeth on its upper edge, a ring encircling the jaws, and a spring dog pivoted to the ring.

502,826. TROLLEY WIRE INSULATOR; L. McCarthy, Boston, Mass. Application filed March 27, 1893. An insulator for overhead conductors having a bell-shaped case and projecting skirt, inclosing a metallic connection and insulated from the connection by mica, and having an exterior layer or covering of insulating material molded thereon and conforming to the exterior shape thereof, to wholly or partially cover the exterior surface.



No. 502,824.—SECONDARY BATTERY.

502,842. ELECTRIC RAILWAY CONDUIT; R. R. Zell, Baltimore, Md. Application filed Aug. 8, 1892. In a system for propelling cars, an underground conduit having a continuous drain pipe, with perforations along the top of the pipe, and a slot rail, in combination with water deflectors attached to the drain pipe and adapted to deflect and guide the water entering through the rail slot to the drain pipe; trolley rods located in the conduit, a trolley adapted to contact with these rods, and suitable insulators for same.

502,858. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; W. F. Jenkins, Richmond, Va. Application filed June 3, 1892. An insulated feed wire having at intervals contact portions combined with a clamp by which to secure the wire adjacent to its contact portion directly to and against the rail.

502,889. CIRCUIT TESTING APPARATUS; F. S. Palmer, Boston, Mass. Application filed March 20, 1893. In circuit testing apparatus, a continuous outside wire common to all floors, a group of inside wires, one for each floor, electrically arranged in multiple, combined with a switch adapted to change such system of wires from multiple to series in the act of testing.

502,935. SELF-WINDING ELECTRIC CLOCK; F. M. Schmidt, Brooklyn, N. Y. Application filed Jan. 19, 1893. In a self-winding clock an electric magnet and armature and a crank connected therewith for winding the clock mainspring, combined with means for throwing the crank from the dead centre.

502,948. ELECTRIC ARC LAMP; L. H. Buchanan, Pasadena, Cal. Application filed Sept. 25, 1891. A pair of disc-like electrodes each approximating a complete circle in area and sustained by an arm located near the outer edge of the disc, in combination with regulating mechanism for establishing the arc and regulating the length of same. (See illustration.)

502,965. ELECTRODE AND FIRING EXPLOSIVES; J. N. and H. J. Harrison, San Francisco, Cal. Application filed June 8, 1892. In an electric firing device, electrodes, enlarged heads or tips on the outer ends thereof, and sleeves or tubular parts on the electrodes, and means for operating the sleeves.

502,981. ELECTRICALLY OPERATED HYDRAULIC ELEVATOR; E. Marshall, Boston, Mass. Application filed Nov. 19, 1892. The combination with a hydraulic elevator system of a pump and suitable machinery actuating it in conjunction with an electric motor, an electric motor being engaged by such with the pump and so actuated by a pressure diaphragm engaged as described, a three-point switch, rheostat and governor motor.

502,983. ELECTRIC SWITCH; J. H. McEvoy, Waterbury, Conn. Application filed Dec. 31, 1892. The combination with rotary discs having peripheral contacts, of contact bars having binding posts formed of enlarged bases or feet made in one piece with the contact bars, and provided with wire inlets and binding post screws.

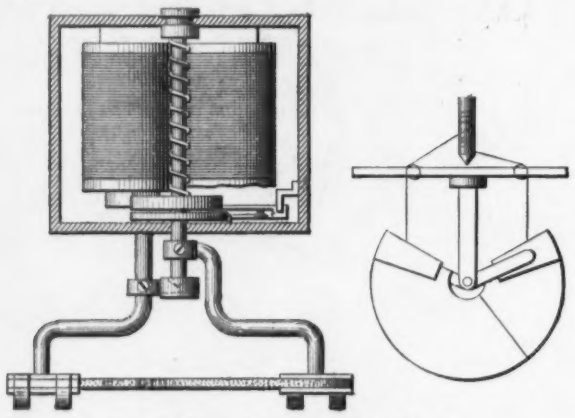
502,988. ARMATURE AND METHOD OF CONSTRUCTING SAME; H. F. Pearshall, Lynn, Mass. Application filed April 10, 1893. The combination with an annular armature core having internal undercut grooves, of a supporting shell having corresponding undercut grooves, keys fitting snugly into one set of grooves and loosely into the other set, and babbitt or similar material filling the space between the keys and the latter set of grooves.

503,016. ELECTRIC IGNITING DEVICE FOR GAS ENGINE; F. E. Remper, New York. Application filed Feb. 8, 1893. An electric igniting device for gas engines, comprising permanently separated rigid electrodes insulated in the cylinder, the electrodes being formed with sharp-edged heads at their inner ends, inside the cylinder, and a flexible sparking strip held insulated on the reciprocating piston and adapted to make contact with the heads of these electrodes.

503,038. REGULATION OF ALTERNATING CURRENT MOTORS; M. von Dolivo-Dobrowolsky, Berlin, Germany. Application filed Dec. 23, 1890. In an alternating current motor, the combination of a field magnet provided with three or more coils or sets of coils, a like number of circuits connected to the coils, means for supplying the circuits with differential-phase alternating currents, a rotative armature having coils which are independent of each other, adjustable resistances equal in number to that of the coils of the armature, contact rings on the armature, brushes and conductors whereby each coil of the armature is separately brought in circuit with one of the resistances, and a regulating mechanism common to all the resistances.

503,039. CONDUCTOR SUPPORT AND INSULATOR; W. B. Essick, Manley, Neb. Application filed Feb. 1, 1893. The insulator for an underground trolley wire, comprising the support of non-conducting material, having an opening extending therethrough in combination with the conducting or trolley wire, shoes secured to the wire and a brace passed through the opening and connecting with the shoes.

503,099. MULTIPLE SWITCHBOARD SYSTEM; C. E. Scribner, Chicago, Ill. Application filed Oct. 13, 1891. The combination of the springjack having two line springs of different lengths and a frame insulated from the line springs with a plug having two contact pieces, one adapted to make contact with one of the line springs, and the other to make contact with both the other line springs and the frame of the jack.



No. 502,948.—ELECTRIC ARC LAMP.

503,100. ELECTRICAL RAILWAY SIGNAL; B. C. Seaton, Nashville, Tenn. Application filed March 2, 1893. The combination with a controlling switch comprising a double set of pole changing contacts adapted to be engaged by bridging contacts on the switch lever, and a set of short circuit contacts also adapted to be bridged by the contacts of the switch lever, of a source of electricity controlled by the switch, annunciating apparatus also controlled by the switch, and a circuit including another source of electricity and independent of the other source of electricity.

503,101. ELECTRIC RAIL BOND; B. C. Seaton, Nashville, Tenn. Application filed March 2, 1893. A bond or connector concealed and protected by the fish plates and consisting of a plurality of rods connected to the bolts and having an elastic play of action.

503,106. ARMATURE FOR DYNAMO-ELECTRIC MACHINES AND MOTORS; S. S. Wheeler, New York. Application filed April 24, 1893. This invention comprises a core which is made up of two parts, each composed of laminations of unequal lengths of arc, the longer laminations overlapping the shorter ones at both ends, and the long and short laminations of one part being complementary in lengths of arc to the short and long laminations respectively of the other part, and reversed in position relatively thereto, so that the two parts fit together with a mortise joint and the laminations form complete rings when the parts are fitted together. (See illustration.)

503,108. INCANDESCENT ELECTRIC LAMP; J. H. Bates, Hoboken, N. J. Application filed Jan. 19, 1893. The combination of a lamp bulb provided with an open neck tapering inward, a tapered collar fitting the collar, the collar and plug being adapted to form an airtight closure for the hub, and a base secured to the neck of the lamp.

UNITED STATES PATENTS ISSUED AUGUST 15, 1893.

[IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N. Y.]

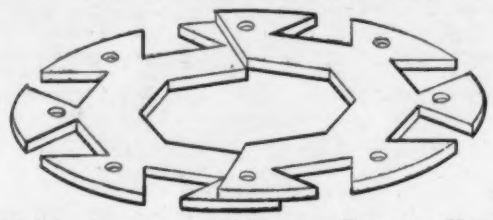
503,115. TEST SYSTEM FOR MULTIPLE SWITCHBOARDS; W. D. Allison, Chicago, Ill. Application filed May 14, 1888. The combination with a telephone line connected with different springjack switches on different boards, of a loop plug inserted in one of the switches, and indicating apparatus adapted to indicate, when the line is busy, a resistance in the line less than normal.

503,132. BATTERY JAR; A. M. Gee, Edgar, Neb. Application filed Feb. 18, 1893. The combination of an airtight battery fluid reservoir having a central opening in its top and an interior neck depending inwardly from the opening, a battery cell or jar adapted to rest flatly at its bottom on top of the reservoir and provided with an integral fluid tube depending centrally from its bottom and removably projecting through the neck into the reservoir to a point near the bottom of the latter, and a valved air tube connected to the top of the reservoir and communicating with its interior.

503,157. SWITCH FOR ELECTRIC CURRENTS; Wm. McNeill and J. H. Tinder, Winchester, Ky. Application filed May 31, 1892. The method of metering electric light service, which consists in breaking the main circuit at stated intervals for a period of such short duration as to not perceptibly affect the lights on the circuit, and causing such interruptions to make a record.

503,180. ELECTRIC SWITCH; E. P. Warner, Chicago, Ill. Application filed Oct. 29, 1892. A contact finger provided with a transverse slot at one end, points of support on each side of the slotted end adapted to react approximately at right angles to the plane of the slot, and to permit the lateral movement of the free end of the contact finger by the partial closing of the slot.

503,181. CONNECTOR; H. L. Webb, New York. Application filed Feb. 28, 1891. This consists of a metal sleeve in combination with the crimped or corrugated free ends of the wires or strips to be joined, these corrugated ends being interlocked by overlapping, and held against lateral displacement by the surrounding sleeve, and means for the prevention of the longitudinal displacement of the sleeve.



No. 503,106.—ARMATURE FOR DYNAMO-ELECTRIC MACHINES AND MOTORS.

503,183. ALTERNATING CURRENT MOTOR; F. A. Wessel, Boston, Mass. Application filed April 3, 1888. The combination with an electric motor of the continuous current type, of a connection through the armature from an alternating supply wire or source, a separate field energizing circuit in which the alternations coincide with those of the supply wire, and intermediate retarding or lagging devices between the same and the field coils adjusted as described to bring the alternations of field magnetism into practical coincidence with the alternations in the armature.

503,186. ELECTRICAL CONDENSER; Alex. Wurts, Pittsburgh, Pa. Application filed Oct. 5, 1892. In a condenser a dielectric composed of cotton moist with elaine oil.

503,187. FIRE ALARM AND INDIVIDUAL ELECTRIC CALL; John Young, Chicago, Ill. Application filed July 18, 1884. This consists of terminal segments for each bell circuit, arranged in a circle or series of concentric circles, a source of electricity to one side of which the bell circuits are connected in multiple, a circuit closer connected to the other side of the source of electricity and adapted to move over the terminal segments, a clock mechanism for moving the circuit closer, a stop normally in the path of the circuit closer adapted when removed from the path to permit the circuit closer to pass over the terminal segments to close the bell circuits consecutively and to consecutively open the same, whereby the bells may be rung consecutively and one at a time to sound a general alarm without unduly taxing the source of electromotive force.

503,193. CLEAT; D. B. Bronson, Chicago, Ill. Application filed Feb. 14, 1893. The combination with a device of the kind specified for securing conduits and the like and consisting of a cross-piece with a perforation about midway between its ends, the length of the cross-piece approximating twice the diameter of the conduit to be held thereby, and legs on the ends of the cross-piece, the length of the legs approximating the diameter of the conduits to be held thereby, of a headed nail or pin to pass through the perforation and between the conduits held by the cross-piece and legs and into the wall or the like to which the conduits are to be secured.

503,213. ELECTRICAL RECIPROCATING MOTOR; H. S. McKay, Boston, Mass. Application filed May 13, 1892. In an electromagnetic reciprocating tool or engine, the combination with the armature, a commutator composed of a sliding frame and fixed contacts, the frame provided with yielding contact pieces extending on opposite sides of it, and a conducting medium connecting the pieces and the fixed contacts also situated on opposite sides of the sliding frame and adapted for electrical connection with the yielding contacts during their sliding movement, whereby the magnetic devices are alternately energized and short-circuited.

503,252. ELECTRIC SWITCHBOARD SIGNAL; F. A. Pickernell, Newark, N. J. Application filed May 15, 1893. The combination of an electric circuit; a high resistance and a low resistance signal included therein; a source of current also included therein; a normally closed branch or derived circuit shunting the high resistance signal and the source of current, and including an independent and equal source of current, so connected that the two sources oppose each other through the signal, as long as the branch is closed; and circuit controllers in the signal and branch circuits respectively, controlling the continuity and thereby the operation of the signals (see illustration).

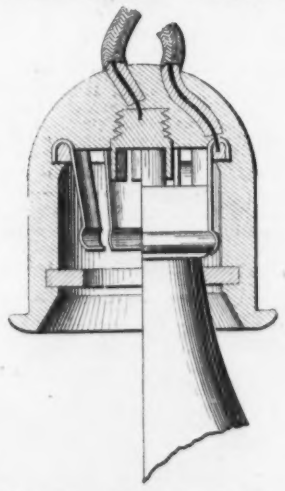
503,279. CONTROLLING SWITCH FOR ELECTRICALLY PROPELLED VEHICLES; H. P. Davis, Pittsburgh, Pa. Application filed Jan. 7, 1893. In combination with two driving motors of an electric car, a reverser consisting of two sets of studs, each consisting of two brush studs and a field magnet stud between them, and means for electrically connecting the sets.

503,321. METHOD OF AND APPARATUS FOR THE TRANSMISSION OF ELECTRICAL ENERGY; R. M. Hunter. Application filed Nov. 21, 1892. In a system for electrical transmission of energy, the combination of a line circuit, a continuous current generator connected directly to the line circuit, an alternating current generator, and a transformer having one of its coils in circuit with the line and its other coil in circuit with the alternating current generator.

503,349. INCANDESCENT LAMP SOCKET; C. T. Lee, Boston, Mass. Application filed May 3, 1892. A molded socket for incandescent lamps, provided between its mouth and terminals with a ring of rubber, the ring of rubber being secured in an annular recess in the socket (see illustration).

503,371. WRITING RECEIVER; A. Heil, Frankisch Crumbach, Germany. Application filed Jan. 21, 1893. The combination of a platen and feed roll for the tape, a pencil or style lever adapted to the platen, a key, and operative connection between the key and feed roll for advancing the tape on the depression of the key, and a tappet arranged to engage with the pencil or style lever and in operative connection with the key.

503,372. TELEGRAPHIC APPARATUS; A. Heil, Frankisch Crumbach, Germany. Application filed Feb. 13, 1893. The combination of feed rolls for the tape, a ratchet wheel for these rolls, a marking lever adapted to the tape, an armature lever, an electromagnet adapted to the lever, and tappets attached to the lever and disposed to engage respectively with



No. 503,349.—INCANDESCENT LAMP SOCKET.

503,376. FIRE ALARM BOX; J. G. Kraetz, Buffalo, N. Y. Application filed June 3, 1893. The combination with the door having an opening, a bolt or catch and a handle for operating the catch, arranged in the rear of the opening, ways arranged above and below the opening on the rear of the door, and a slot arranged in the edge of the door in line with the ways.

503,384. CLEAT FOR ELECTRIC WIRES; Jacob Pawolowski, Cincinnati, O. Application filed Jan. 7, 1893. The combination of clamping strips recessed to receive insulating bushings and perforated to receive securing screws, and two part insulating bushings secured between the clamps.

503,421. TROLLEY WIRE FINDER; H. C. Jones, Montgomery, Ala. Application filed May 31, 1893. The combination with trolley pole and trolley, of a clamping piece secured to the trolley pole, a bracket pivoted on the clamping piece and provided with means for fixing its position in relation to the pole, and the guide mechanism supported on the bracket.

503,425. NON-CORRODIBLE PLASTIC COMPOSITION; J. W. Kidwell, Washington, D. C. Application filed Oct. 18, 1892. This is a composition for building blocks and similar purposes, composed of titanic minerals and asphaltum, and containing about eight parts of the former to two of the latter.

503,427. BINDING POST FOR ELECTRICAL CONNECTIONS; A. Kohl, Centralia, Ill. Application filed March 24, 1893. This is formed of a body of insulating material bored axially and provided with a clamping screw, and axially bored contact screw inserted in the end of the post, and a clamping nut placed on the contact screw.

503,443. TROLLEY WIRE SWITCH; E. A. Sperry, Chicago, Ill. Application filed April 1, 1892. The combination of successive main sections of trolley wire with a short intermediate trolley wire, and cross connections from each switch to the other, whereby when the trolley moves toward the short section, one switch is operated to place the short section in circuit, and when the trolley moves from the short section the same switch is operated to cut the section out of circuit.

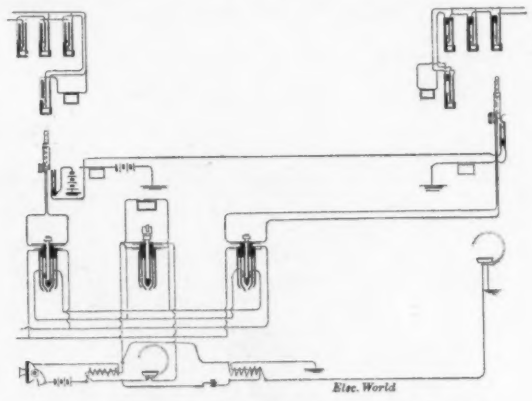
503,445. METHOD OF WINDING COILS FOR DYNAMO ELECTRIC ARMATURES; Elihu Thomson, Swampscott, Mass. Application filed April 19, 1893. This consists in winding a coil on a form in trapezoidal shape, then removing it and distorting or bending the trapezoid into two incomplete rectangles, and then bending these into different planes.

503,449. METHOD OF WINDING COILS FOR DYNAMO ELECTRIC ARMATURES; J. B. Blood, Lynn, Mass. Application filed April 19, 1893. This consists in winding the coil on a trapezoidal form, then removing it therefrom, then bringing its parallel sides together, then bringing its ends to an approximate right angle with such parallel sides and then opening the coil to form two incomplete rectangles lying in different planes.

503,453. REGULATOR FOR ELECTRIC MOTORS; J. C. Davidson, Prince's Bay, N. Y. Application filed March 8, 1893. The combination in an electric motor of the motor armature, and the resistance partly in series, and partly in shunt.

503,487. ELECTRIC ENGINE; W. Lawrence, N. Y. Application filed Aug. 17, 1892. The improvements in electric controlling apparatus consisting of a forked brush formed from a continuous strip or piece pivoted to the bed of the machine, an arm secured to the pivot for moving the brushes vertically, which arm is connected to a rod or bar and adapted to be operated from either end of the apparatus by a lever, and thereby control the movement of the apparatus.

503,505. RAILWAY SIGNALING; I. A. Timmis, London, England. Application filed Oct. 13, 1892. A signal post provided with bracket and signal arm, a stationary electromagnet, an arm pivoted to the post and provided with a weight, a stop for the arm to rest on, and other connections whereby the signal arm is locked when raised by a weight and the armature is free of the electromagnet.



No. 503,252.—ELECTRIC SWITCHBOARD SIGNAL.

503,519. CONDUCTOR SUPPORT AND INSULATOR; D. T. Bennett, Trenton, N. J. Application filed May 15, 1893. A bracket having a threaded stem, an insulator surrounding the stem, and having shoulders on opposite ends, a band embracing the insulator, and arranged between the shoulders, and provided with diametrically arranged arms, bolts and nuts secured to the arms, and suitable supporting means for the attachment of the bolts.

503,538. ELECTRIC ARC LAMP; L. E. Howard, Plainfield, N. J. Application filed Dec. 20, 1892. This lamp has its arc inclosed in a transparent envelope provided with a separable top, and outer transparent envelope for the purpose described, this outer envelope being closed on all sides, and provided with a detachable cover.

503,539. ELECTRIC ARC LAMP; L. E. Howard, Plainfield, N. J. Application filed June 9, 1893. This lamp has its electrodes around the arc inclosed in a small transparent envelope so arranged as to maintain the gases luminous in the envelope and air-tight against ingress of air, but affording egress for the heated gases developed by the arc.

503,549. INSULATOR; L. McCarthy, Boston, Mass. Application filed Jan. 14, 1893. This comprises a case, metallic portions placed in same, and insulated therefrom, and from each other by layers of insulating material.

503,555. CABLING SYSTEM FOR MULTIPLE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. Application filed Oct. 15, 1888. This comprises two or more switchboards and switches of a multiple switchboard system, wires connecting corresponding switches on the boards, these wires being bound together to form a mass composed of sections with their ends turned up to connect with the switches.

503,562. ELECTRIC TROLLEY WHEEL; J. W. Clark, Menands, N. Y. Application filed Feb. 23, 1893. This consists of a hub, a series of arms radiating from it, each having an ice-breaking shoulder on its inner face, two annular rims formed on the outer ends of the arms, and a groove formed at the base of the arms, the groove being fitted to receive and form a close electrical contact with a trolley wire, the spaces between the arms being carried into and longitudinally across the periphery of the hub for the purpose of forming ice-breakers at the bottom of the groove.

503,566. ELECTRICAL SUPPLY SYSTEM FOR RAILWAYS; J. W. Bates, Minneapolis, Minn. Application filed Feb. 8, 1892. In combination with a double track a series of posts arranged between them, each post provided with a head with openings through its two sides, and a spring-pivoted arm, with its ends projecting through the openings and toward each track, and stationary contacts arranged on the arm to engage same when the arm is operated.

503,567. GALVANIC BATTERY; C. H. Brown, Portland, Ore. Application filed May 3, 1893. A galvanic battery, comprising a containing vessel, negative plates, and a positive plate formed of an alloy of aluminium and zinc.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1826—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y